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CONTENTS

	Page
Aspects of Colonial Development	547
Chemical Stimuli and Insect Behaviour. By Dr. V. B. Wigglesworth, F.R.S.	550
Process Chemistry for the Chemist. By Dr. E. F. G. Herington	550
Mechanism of Nuclear Physics Counters. By Dr. C. H. Westcott	551
On Understanding Science. By Prof. Herbert Dingle	552
Destruction and Rehabilitation of an Island Fauna	552
The Canine Cult. By Brian Vesey-Fitzgerald	553
Research Services in East Africa. By Dr. E. B. Worthington	554
Scientific Aspects of Colonial Development	556
Nature of Incentives. By Prof. C. A. Mace	557
Transmission of Effects from the Endings of Nerve Fibres	558
Obituaries:	
Dr. William Cullen. By Dr. S. W. Smith, C.B.E.	560
Sir Thomas Crozier	561
News and Views	562
Letters to the Editors:	
Two New British Minerals.—Dr. F. A. Bannister and Prof. S. E. Hollingworth	565
Structure of Co_2Al_9.—Mrs. A. M. B. Douglas; Dr. G. V. Raynor and M. B. Waldron	565
Decay of Barium-139.—L. R. Shepherd and J. M. Hill	566
Preparation of Pure Iron-59 of High Specific Activity.—A. W. Kenny and W. R. E. Maton	567
Distribution of Ice-Particle Nuclei in the Free Atmosphere.—H. P. Palmer	568
Frictional Electrification of Sand.—E. W. B. Gill	568
Influence of Reactive Feedback Networks on the Response of Galvanometers.—P. Savic	569
Biological Properties of a Substance Isolated from Wheat Middlings and of Hydroxymethylfurfuraldehyde.—Dr. T. B. Heaton, O.B.E., and G. M. Robinson	570
Assay of *nor*Adrenalin and Adrenalin in Extracts of Nerves and Tissues.—Prof. U. S. v. Euler	570
Alloxan Diabetes in Dogs with Renal Pedicles Clamped.—Prof. B. A. Houssay, For.Mem.R.S., and Dr. C. Martinez	571
Effect of Hypophysectomy on Glycogen Deposition in Isolated Muscle.—Dr. J. Bornstein and J. F. Nelson	572
Cytochemical Demonstration of Ketosteroids.—R. J. Boscott, Anita M. Mandl, Dr. J. F. Danielli and Dr. C. W. Shoppee	572
p-Aminobenzoic Acid a Growth-Factor for Certain Brewer's Yeasts.—Cyril Rainbow	572
A Test for Mutagenicity of Methylcholanthrene.—Dr. S. Bhattacharya	573
Fungal Mutations Obtained with Methyl Xanthines.—Dr. Nils Fries and Bengt Kihlmann	573
Yeast and Rickets.—Dr. Th. J. de Man; Dr. E. Hoff-Jorgensen	574
Stimulation of Adventitious Root Formation by Fungal Metabolic Products.—Dr. M. A. Mostafa and M. S. Naim	575
Blood System of the Gut of *Arenicola marina*.—Doris M. Kermack	576
Extrafloral Glands of Cucurbitaceæ.—Dr. H. L. Chakravarty	576
New Colour and Fluorescence Reactions in the Steroid and Synthetic Œstrogen Series.—Dr. R. J. Boscott	577
Fermentation of Pyruvate, β-Hydroxybutyrate and of C_4-dicarboxylic Acids by some Butyric Acid-forming Organisms.—Dr. Georges N. Cohen and Germaine Cohen-Bazire	578
British Abstracts.—Sir David Chadwick, K.C.M.G.	578
Hexosamine Components of the Human Blood Group Substances. By D. Aminoff and W. T. J. Morgan	579
Volatile Cuprous and Silver Salts of Fatty Acids. By A. Keller and Dr. F. Korösy	580
Engineering Students and Mathematics	582
Control of Environment in Horticulture	584
Inter-University Relations and Exchanges	585
Health of the People of Britain. By Dr. G. Lapage	586
British Council: Annual Report	587

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ASPECTS OF COLONIAL DEVELOPMENT

THE fifth report from the Select Committee on Estimates for the Session 1947–48 (London: H.M. Stationery Office), with its forthright comments on Colonial development, makes its appearance at an appropriate moment. It is based in part on the observations of some of its members as a result of a visit to West Africa, and it has some relevance to the report, published later, of the commission of inquiry into the disturbances and underlying causes of these disturbances in the Gold Coast during February and March of this year. The recommendations and conclusions are equally of interest in relation to the recent report on "Colonial Research 1947–48". They emphasize the value and importance of the work being done by the Colonial Research Council, which has now replaced the Colonial Research Committee, and by the Colonial Products Research Council, the Colonial Social Science Research Council and the committees responsible for medical research, insecticide research, agricultural, animal health and forestry research, as well as the urgent need for the Colonial Economic Research Committee to function effectively.

In all these reports, two factors stand out as determining the successful issue of Colonial welfare and development: the problem of education and that of scientific man-power. Once again it is made manifest that shortage of qualified workers handicaps the work of the Social Science Research Council, of the Medical Research Committee and of the Insecticides Committee, and both the latter Committees realize how closely the effective utilization of results of their work depends on securing the co-operation of the native peoples.

Colonial research cannot, in fact, be pursued without regard to the question of native education, even of literacy at the lowest level. One passage in the Gold Coast report drives this lesson emphatically home. The economy of the Gold Coast rests on its four hundred million cocoa trees. Of them, one tree in eight is now affected by the virus disease known as swollen shoot, and if the disease is unchecked it is estimated that the cocoa industry will have disappeared in twenty years. The Government has accepted the opinion of its advisers that the way to check this incurable disease is by cutting down the diseased trees. Violent popular feeling and resistance to this destruction was aroused, because it was believed to be inspired by malign political motives; and the cutting out of the diseased trees has been stopped.

That passage in the report is pregnant with meaning for the whole future of Colonial welfare and development. While misrepresentation can create this kind of distrust, no mere adjustment of constitution or administration can restore the health of the body politic. The whole economy is put in jeopardy, and it is beyond the power of science or of Government to raise the standards of living of the native peoples, or even to avert a catastrophic fall. The problem of literacy, the programme of mass

education, and the restoration or fostering of confidence beyond the power of the agitator to disrupt, must be the first tasks; and until they are undertaken there is no hope that the man of science can make the contribution to native welfare of which he has become increasingly conscious since Lord Hailey published his "African Survey" ten years ago.

Nevertheless, although the first task is to promote understanding, even at this stage the man of science has a contribution to make, as was made abundantly clear on several occasions during the recent meeting at Brighton of the British Association. This point is well brought out by Dr. E. W. Smith in the Frazer Lecture in Social Anthropology before the University of Liverpool delivered in October 1946, and recently brought up to date and published (London: Lutterworth Press, 1948. 3*s*. 6*d*. net). Events have well attested the soundness of the four factors upon which Dr. Smith suggested that the success of projects under the Colonial Development and Welfare Act depends: a sufficient supply of competent men and women to operate the plans; the goodwill and effective co-operation of the native peoples themselves; the wise planning and execution of the schemes by men and women who understand the native environment and the working of the native mind; and the co-operation of the economist, the agriculturist, the medical man, the psychologist, the nutritionist, the educationist and administrator, as well as others in the team-work required to devise and execute detailed schemes for each district. Dr. Smith is arguing above all for the anthropologist to make his vital contribution to the understanding of the native mind, and for the Government to make increasing use of such men in the task of government. His plea for social science to be used as an instrument of social engineering, and for more social scientists for the Colonial Service, is supported by the important section of the Gold Coast report already noted.

That Dr. Smith does not stand alone in his views was indicated in an address given by Sir Harold Hartley in Johannesburg in August at a conference of scientific and technical societies. Sir Harold, after urging a great extension of surveys of the material and human resources, limitations and needs of the relatively undeveloped parts of the world, reviewed the main factors likely to limit world economic advance, and the part of scientific workers in overcoming them. In spite of the huge increases in agricultural output which are potentially possible on the basis of existing knowledge, he said, man is still the limiting factor in peaceful advance. The same conclusion might well be drawn from the fifth report of the Select Committee on Estimates, although it concentrates attention rather on human limitations on the administrative side.

The Select Committee recognizes clearly that co-operation in development involves the association with the planning, of such organised opinion as may exist, of a carefully worked out policy of technical and vocational training related to the needs of a developing country for skilled man-power at all levels, and communal development or 'mass education' to induce the bulk of the population to take an active interest in their own welfare. It considers that the Nigerian Development Plan suffered from the beginning in that too little attention was paid to the need for associating African opinion with the various committees established to deal with it. This has now been to some extent righted, although African representation on the Central Development Committee is still inadequate.

So far as the felling of the diseased cocoa trees was a factor in the Gold Coast riots, it has been suggested that the Government failed to secure that its reasons were fully understood by native opinion, although improper methods of execution were also alleged. To engage the active co-operation of the native people themselves is not always easy, and may indeed involve questions of constitution as well as of administrative method. Communal development is still experimental; and on the information side, as the Select Committee notes, there is need for research into the kind of film appropriate to undeveloped peoples. Support from development funds of a scheme of research for ascertaining the reactions of African audiences is recommended. Similarly, it expresses its approval of the active pursuit of a comprehensive policy for the development of broadcasting throughout the British Empire, and urges that the closest informal contact should be maintained between the Colonial Office Information Department and the British Council in foreign countries.

This question of confidence and information has a bearing also on the part which private enterprise has to play in Colonial development. It is the declared policy of the Colonial Office to encourage private enterprise; but private enterprise cannot play its proper part in development so long as the belief exists among the Colonial peoples that it is unfairly exploiting them; nor, it might be added, while private enterprise elsewhere continues to be condemned by Government spokesmen. The Select Committee refers to local feeling against the United Africa Company in particular, but there is some hope for a settlement which will remove the two main grounds for such feeling.

The matter is not entirely divorced from that of the public development corporation. It is the responsibility of Government to prevent an undue proportion of the trade and industry of any particular Colonial area from becoming dominated by any trading organisation or group, and the Select Committee points out that in spite of the formal assurances of the Overseas Resources Development Act of 1947, it will be necessary to secure that such bodies as the Colonial Development Corporation and the Overseas Food Corporation do in practice respect the interests of the local Colonial people. The obvious danger is that of well-meant authoritarianism. Experience with the Cameroons Development Corporation indicates that special attention must be given to the relationship between such corporations and the local administrative authority.

The problem is in fact essentially one of administration—of securing that justice is not merely done but also seen to be done. The Select Committee makes no specific recommendations here; but the

survey it recommends of the overall requirements of the Colonies for capital equipment for Government schemes, public corporations and private enterprise, should by eliminating some causes of friction make a distinct contribution here, as well as in the immediate objective of facilitating real planning in place of the agglomeration of departmental suggestions masquerading as the Nigerian Ten-Year Development Plan, on which the Select Committee makes the caustic comment: "This is not planning". Such a survey is the counterpart of the early investigation also recommended into the additional financial provision likely to be required to complete existing development schemes, and into the need for extending the ten-year period originally contemplated.

By and large, it may well be true that the administrative mistakes which the Select Committee criticizes are in part due to the overburdening of senior officers in the Colonial Service, and the Committee's observations on the shortage of staff should be noted. The Secretary of State for the Colonies stated in the House of Commons on July 8 that, during the last two and a half years, 3,300 men and women had been recruited for the Colonial Service, and on the administrative side the intake of the last two years was equal to that of eleven normal years. Excellent reports had been received on the quality of these recruits, and Mr. Creech Jones paid a warm tribute to the co-operation of the Universities of Oxford, Cambridge, London and elsewhere in training these recruits.

Nevertheless, the Select Committee reports that in May 1948 there were 1,185 vacancies in the Colonial Service, the greatest demand (315) being for men with engineering and architectural qualifications, while 168 administrators, 136 medical men and 110 agriculturists are still required. Apart from the strain on existing staff, it is imperative that immediate steps should be taken to overtake present shortage if Colonial development is to proceed smoothly. The shortage is equivalent to about three years ordinary intake, and has to be viewed in relation to the demand for trained man-power and woman-power as a whole, just as the Select Committee insists capital requirements of the Colonies must be reviewed.

That view presumably will be taken to some extent by the Advisory Council on Scientific Policy as suggested in its first annual report; but in the meantime the Select Committee makes several suggestions to secure the fullest use of available technical and scientific staff without lowering standards of qualifications. The limited number of fully qualified technicians available should concentrate on training staff for technical positions, and schemes should be adopted for recruiting into the forestry, agricultural and veterinary services men without academic qualifications but of good personal qualities and natural aptitude, and which would provide for academic training at a later stage when the pressure on the schools of forestry should have decreased. The requirement of university training as a qualification for recruitment might also be waived, and the temporary seconding of staff from Home to Colonial Service should be exploited to the utmost. Attractive schemes for seconding should be made for all technical services, providing appropriate guarantees in regard to promotion on return to Great Britain, and short-term contracts should be used to the fullest extent to obtain for the Colonies the services of scientific men and technicians with the highest qualifications, and development funds should be used for this purpose.

The Select Committee's recommendations here as well as in regard to salary scales and the provision of refresher courses are in line with those of the Barlow Committee for scientific staff generally. Clearly, to secure the most effective and best balanced distribution of scientific and other trained man-power between Britain and the Colonies involves encouraging mobility to the greatest possible extent, quite apart from the very favourable reactions such interchange has on scientific work itself. In all this the fullest possible encouragement must be given, and the greatest possible use made, of Colonial men and women themselves. Such association at all levels in the Colonial Service must prove a powerful factor in securing the understanding and co-operation of the Colonial peoples in development of their territories, nor should the influence of greater attention to the needs of Colonial students in Great Britain, both in regard to amenities or information, be overlooked.

Mr. Creech Jones' speech in the House of Commons on July 8 shows that the trend of the Select Committee's observations is fully appreciated. He stressed three points in regard to economic policy: the essential requirement of understanding and co-operation from the Colonial peoples themselves, to whom it must be made clear that the development plans are primarily concerned with the improvement of their trade and economic status and with the strengthening of the economies of their territories; the necessity for a sound economic basis for Colonial welfare; and growth of regional co-operation in this field with the French, Belgian and Portuguese Governments. During the past year a series of technical conferences has already taken place and more are planned on problems of technical development, communications, health, etc. The Government has also entered into discussions with the French and other associated Governments on the possibilities of further co-operation in regard to development schemes.

In spite of all this promise of genuine international co-operation in tackling problems of Colonial development in such areas as West and Central Africa, there is one seriously disturbing factor. That is the failure of the Trusteeship Council to reach the standard of constructive criticism set by its predecessor, the Mandates Commission of the League of Nations. The Select Committee's report demonstrates the weaknesses of British planning of Colonial development, and is a challenge to more constructive thinking and realistic planning in the light of inherent limitations of resources of materials and men and women. It is equally a rebuke to the irresponsible criticism and political polemics, with their disregard of the facts and conditions in the

trusteeship of Colonial territories which has marred the proceedings of the Trusteeship Council, and is making it a disturbing factor rather than one which promotes the goodwill and understanding upon which Colonial development and welfare depend. Great Britain is faithfully meeting its obligations under the charter of the United Nations Organisation in regard to the provision of statistical and other technical information on economic, social and educational conditions, and the Colonial Office has done well to make the position plain in its recent Memorandum on Information on Non-Self-Governing Territories (London: H.M. Stationery Office, 1948. Colonial No. 228. 1*s.* net).

International co-operation could do something to diminish the present difficulties in Colonial development, particularly in the attack on technical problems, and in such matters as transport. No doubt the help of independent international men of science would be valuable in overcoming prejudices such as those which hamper the eradication of the swollen shoot disease of the cocoa tree. But such collaboration is only possible in an atmosphere of goodwill, and where there is manifest the willingness to make impartial investigation and the comparative study of different Colonial systems which characterized the work of the permanent Mandates Commission of the League of Nations.

CHEMICAL STIMULI AND INSECT BEHAVIOUR

Chemical Insect Attractants and Repellents

By Prof. Vincent G. Dethier. Pp. xv + 289. (London: H. K. Lewis and Co., Ltd., 1947.) 25*s.* net.

INSECTS live in a world of tastes and odours. To understand their reactions to the varied chemical factors in their environment would be a long step towards comprehending their ecology and would provide a firm basis on which to build certain methods of control. It is around these theoretical and practical considerations that Prof. Dethier has written his book on the action of chemical attractants and repellents in the life of insects. Unfortunately, exact knowledge in this field is very limited, and the contributions of the applied entomologist are copious but wholly empirical. None the less, this book should serve a useful purpose in bringing together in one volume what is known of the role of chemical attractants in the feeding, sexual and egg-laying behaviour of insects.

The botany and chemistry of the essential oils of plants and the relation of these substances to the choice of food-plants is reviewed—from the classic work of Verschaffelt on the predilection of Pierid larvæ for plants containing mustard oils to the recent detailed work of the author himself on the feeding habits of *Papilio* species in relation to the essential oils of Umbelliferæ and other plants. The chemistry of fermentation and the products of decomposition of protein and fat are considered alongside the extensive empirical literature on the production of attractants for the codling moth, fruit flies, blowflies and other insects. It is no fault of the author that this subject consists chiefly of lists of facts with few guiding principles. There is a valuable chapter in which the varied types of olfactometers and venturi type flow-meters are described, together with the methods of controlling the molecular concentration of odorous substances and determining the thresholds of response. On the practical side, the use of attractants in devising traps—for sampling populations and timing the application of insecticides or for actually reducing populations—is described in detail; and the whole subject of insect repellents is reviewed.

At the beginning of the Second World War the standard mosquito repellent was still oil of citronella; but commercial firms in the United States had evolved three synthetic repellents: dimethyl phthalate, 2-ethyl-hexane-diol 1,3 (Rutgers 612) and αα-dimethyl-α-carbobutoxydihydro-γ-pyrone (indalone). At great expense, large teams of American workers during the War tested thousands of additional substances; but the only practical outcome was the recommendation to use a mixture of the three named chemicals in the proportion of 6 : 2 : 2. No advances were made in the general knowledge of repellents. Indeed, the most valuable contribution in this field during the war years was the paper by Christophers[1], working almost single-handed; a paper which appeared too late for inclusion in Prof. Dethier's book.

The writing of this book was completed while the author was serving with the Armed Forces overseas. It has not been possible, therefore, for him to include certain recent ideas which go far to clarify thought on some of the fundamental questions involved. It has been pointed out by J. S. Kennedy that repellency is not a reaction but a change in distribution; and this altered distribution may be brought about in a variety of ways. For example, the author states categorically that D.D.T. possesses "no repellent qualities whatsoever". But slight D.D.T. poisoning causes excitation, and this in turn leads to such a change in distribution that insects are, in fact, strikingly repelled from buildings treated with D.D.T. Similarly the author ascribes the change of host plant by aphides at different seasons to physiological changes in the insect resulting in altered taste preferences. But it is becoming increasingly clear that the nutritional value of the host plant, as determined by the physiological condition of its foliage, may play a part at least as great as do specific flavours in inducing feeding and multiplication and so the building up of aphid populations.

V. B. WIGGLESWORTH

[1] *J. Hyg.*, **45**, 176 (1947).

PROCESS CHEMISTRY FOR THE CHEMIST

Chemical Process Principles

By Prof. Olaf A. Hougen and Prof. Kenneth M. Watson. Part 2: Thermodynamics. Pp. xv + 437–804 + xvii–xlviii. 30*s.* net. Part 3: Kinetics and Catalysis. Pp. xv + 805 – 1107 + xvii – xlviii. 27*s.* net. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.)

THESE volumes consider process problems of a physico-chemical nature and they do not contain any detailed discussion of equipment, of selection of materials for construction or of mechanical design. As the majority of chemical engineers in Great Britain

first graduate in chemistry and only later specialize in their chosen subject, this approach should be of particular interest to them.

The treatment rests heavily upon recent American development as is shown by the number of references to American literature, which comprise 90 per cent of the total.

Part 2 opens with the consideration of the second law and quickly proceeds to the discussion of entropy and thermodynamic relationships. Modern methods are used throughout, as is exemplified by the inclusion of Shaw's method for making thermodynamic tranaformations.

Subsequent chapters consider the application of fundamental principles to problems in the compression and expansion of fluids, power generation and refrigeration. The treatment is developed for solutions and mixtures of various types by introducing the chemical potential, fugacity and activity concepts. This approach leads naturally to a study of vapour-liquid equilibria and to the fitting of experimental data to expressions such as the Van Laar equation. A chapter treats chemical equilibria and contains B. F. Dodge's useful discussion of the feasibility of a chemical reaction. The concluding section may be quoted as an example of the bold use which is made of fairly advanced recent methods for the solution of practical problems. These forty-seven pages deal with the calculation of thermodynamic properties from molecular structure by the method of group contributions and also by the more refined statistical methods.

Part 3 treats the subject of the kinetics of industrial reactions, which has rarely been considered elsewhere, and is thus in contrast with Part 2, where the development is along the lines that American thermodynamics has been following for many years. Encouraged by the recent advances in the theory of absolute reaction-rates the authors have applied the conceptions to the study of homogeneous, heterogeneous and catalytic systems of industrial importance. Particular attention is given to the interpretation of pilot-plant data. Economic considerations are emphasized and problems are included in the establishment of the optimum conditions of operation.

In this volume also the emphasis is on American publications. Frequent references are made to the International Critical Tables for experimental data and not to the original works.

Reactions are studied in terms of the general mechanism and in this way surface reactions are considered from the viewpoint of adsorption and dissociation, but there is no discussion of types of catalyst.

Calculations drawn from rather limited fields are often treated in considerable detail, for example, the work on codimer. The study of catalytic reactions culminates in the section on catalytic reactor design, where the authors state, "It is seldom practicable or possible to develop complete data prior to the design of plant, and the engineer is forced to improvise and extrapolate fragmentary data to conditions far outside the range of his past experience. It is in such cases that sound fundamental principles are of the greatest value in breaking down the available information into component effects and contributions of such simplicity that their individual trends can be estimated with fair assurance".

Homogeneous reactions in flow systems and also uncatalysed heterogeneous reactions such as the nitration of benzene, the combustion of coke, water softening and gas absorption are studied from this aspect.

In America during the recent War there were many examples of the scaling up of processes from the laboratory bench to large-scale production without using plant of an intermediate size. Volume 3 is valuable in indicating how this important subject can be tackled.

Numerous problems are set in both parts. The binding of the books is pleasing, and the quality of the paper is good by modern standards.

E. F. G. HERINGTON

MECHANISM OF NUCLEAR PHYSICS COUNTERS

Electron and Nuclear Counters

Theory and Use. By Prof. Serge A. Korff. Fourth printing. Pp. xi + 212. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.) 18*s*. net.

ELECTRICAL methods of counting the products of atomic disintegration have become widely used in many fields in recent years, and are no longer a tool for the specialist in nuclear physics alone. The Geiger-Müller counter for β- and γ-rays in particular has found increasing application in connexion with the 'tracer' technique. A monograph on this subject is therefore particularly welcome, especially as other works on this subject are by now out of date.

The present book is intended for the users of counters as well as the nuclear physics specialist, and the amount of fundamental physical knowledge assumed is not unduly large. Some acquaintance with the processes of ionization, recombination, etc., is assumed; but this should not deter the non-physicist from perusing the book. The author is an acknowledged expert in research on the mechanism of the Geiger-Müller counter, and, as one would expect, the volume contains a full and detailed account of the processes taking place in such a counter. The behaviour of proportional counters and integrating ionization chambers are also described reasonably fully, but the reviewer feels that the section on ionization chambers for counting is rather brief. The 'gridded' ionization chamber, now often employed when the measurement of the size of the ionization pulse is important, receives no mention, nor does the use of very pure inert gases to give 'fast' chambers in which the formation of negative ions is negligible.

While we would recommend perusal of this book to persons whose only contact with Geiger counters is as a user, it must be admitted that it is not a complete guide to counting technique. Such important matters as statistical errors in counting and the design of experiments to obtain maximum accuracy in a minimum time, for example, are much less fully treated than is the mechanism of the discharge. This book will not enable the non-physicist to dispense with specialist assistance in matters such as calculating the correction for absorption of particles in the counter window. It must also be admitted that the section on electronic circuits is only indicative of the type of circuits which can be used; design of circuits requires a deeper knowledge of circuit theory than can be given in a volume of this size. A few modern techniques, such as circuits for the recording

of delayed coincidences with variable delay-time, receive no mention, and the reviewer has detected a few definite mistakes in the circuit diagrams. In a few places throughout the book, too, the derivation of the formulæ used is not completely clear, and another minor criticism is the use, without definition, of the term 'pre-dissociation'; in view of the importance attached to this process in self-quenching Geiger counters, we feel the term should have been explained.

It is recognized that it is difficult to produce a satisfactory book in a field in which research is still active, and in particular in a field where, as in Geiger counters, much past work has been of the empirical 'cook-book' variety. Within the compass of the present volume, and granted its emphasis on the internal mechanism, it would be difficult to suggest any important improvements. The need for such a book is undoubted, and this one will be of use to the specialist and the general user of counters alike.

C. H. WESTCOTT

ON UNDERSTANDING SCIENCE

On Understanding Science

An Historical Approach. By James B. Conant. (The Terry Lectures.) Pp. xv + 146. (London: Oxford University Press, 1947.) 10*s.* 6*d.* net.

IN this book the President of Harvard University addresses himself to the problem of preparing suitable university courses (whether for graduates or undergraduates is not clear) for the purpose of producing an understanding of science in those whose future work is not to be scientific. He gives reasons why he thinks this important. By "understanding science" Dr. Conant means the acquiring of the special point of view which the successful investigator in a field of experimental science naturally attains, and he considers that this end can be achieved better by the presentation of selected 'case-histories' of particular advances in science than by a philosophical analysis of science as a whole. As illustrations of such case-histories he chooses the investigations of the pressure and elasticity of air in the seventeenth century, the discovery of the galvanic battery, and the development and overthrow of the phlogiston theory. These are outlined, with frequent comments on appropriate digressions which the teacher might make to emphasize salient points.

The definition of science which is implied in these considerations is that "as a first approximation, we may say that science emerges from the other progressive activities of man to the extent that new concepts arise from experiments and observations, and the new concepts in turn lead to further experiments and observations"; and among the most important of the characteristics of scientific investigation that are to be brought out are the influence of new techniques of experimentation and their connexion with the practical arts, the evolution of new concepts from experiment, the difficulties of experimentation and the significance of the controlled experiment, and the development of science as an organised social activity. Dr. Conant does not make the common modern error of transforming the fact that science *has* a social function into the illusion that science *is* a social function, and he is careful to distinguish the history of science from the history of technology; it is the former alone with which he is concerned. The book includes very useful bibliographies relating to the chosen case histories.

Taken as a whole, the book is both important and timely. The examples are admirably chosen and presented. It is claimed that the effort proposed would be a pioneer one, and so far as the United States is concerned (it is evident from various passages that this limitation is in Dr. Conant's mind) this may very well be so, although in Britain something similar has been in operation for some time. Perhaps experience of the working of the scheme might have led Dr. Conant to reconsider his contrast between the historical and philosophical approaches to the understanding of science. These can be made to supplement one another, and there is reason to hold that a course in the philosophy of science based on its whole history will lead to a better understanding of science than the mere recapitulation of selected past events alone, and will correct the error, almost inevitable when science is presented by means of special cases, of confusing casual with intrinsic characteristics. For example, such a course would suggest that the continuously progressive element in science is the growth of the field of correlated observations, and not, as Dr. Conant suggests, "changing concepts and evolving conceptual schemes". Newtonian mechanical science progressed enormously for more than two hundred years with scarcely any changing concepts and evolving conceptual schemes. Again it might help to elucidate the difficulty which arises when Dr. Conant emphasizes the (questionable) "differences in method between the observational sciences . . . on the one hand, and the experimental sciences . . . on the other", but draws all his case histories from the latter.

Such points, however, though important, are of secondary importance. It is much to be hoped that Dr. Conant's book will be widely read and will bear fruit.

HERBERT DINGLE

DESTRUCTION AND REHABILITATION OF AN ISLAND FAUNA

The Fauna of Krakatau, 1883–1933

By K. W. Dammerman. (Verhandelingen der Koninklijke Nederlandsche Akademie van Wetenschappen, Afd. Natuurkunde, Sectie 2, Deel 14.) Pp. xii + 594 + 11 plates. (Amsterdam: N. V. Noord-Hollandsche Uitgevers Mij., 1948.) n.p.

PRIOR to 1883 there existed in the Sunda Straits between Sumatra and Java three small islands, the largest of which, Krakatau, was composed of three active volcanoes, Perboewatan, Danan and Rakata. From May 20 until August 28, 1883, a series of volcanic eruptions succeeded one another until with a final and stupendous explosion the two volcanoes, Danan (400 m.) and Perboewatan, disappeared entirely, and Rakata (800 m.) was split right through the middle, one half of it together with the other two volcanoes sinking into the depths of the ocean, while a cavity 270 m. deep was made in the sea-bed. The main island was originally 9 km. long by 5 km. in breadth with a surface area of 33 sq. km., of which 22 sq. km. sank beneath the sea. Thirty-six thousand people in Java and Sumatra were killed by the resulting sea wave.

In October 1883 Verbeck visited the area and reported that the three islands were completely bare and covered with a hundred feet thick layer of ash and pumice which had exterminated the flora and fauna. The ground was still hot, and scalding steam issued from crevices.

The total destruction of the fauna and flora of Krakatau offered an excellent opportunity for studying re-colonization. Unfortunately very little was known of the previous fauna and, still worse, biologists failed to take advantage of the opportunity presented until too late. Cotteau landed on May 27, 1884, and found that the only sign of animal life was a minute spider; but in 1889 Selenka, who visited the island, found to his astonishment a rich fauna of insects and even giant lizards.

Dr. K. W. Dammerman now presents us with a comprehensive analysis of the work done on this problem of the re-colonization of Krakatau. He has himself made frequent collecting visits to the island, and has for many years specialized on the subject. In the first part of the book the fauna of the island is compared with that of surrounding islands. The re-colonization of other desert areas such as the Katmai volcano in Alaska and the volcano of Jorullo in Mexico is compared with that of Krakatau. The succession of biocœnoses, the sequence of animal categories in the islands and methods of dispersal are all studied in turn. The derivation of the fauna is also discussed. Part 2 (taxonomic part) consists of the complete annotated list, arranged systematically, of the animals now found on the Krakatau islands. Some of these are illustrated by text figures. The same list is repeated in tabular form without annotations to show at a glance the distribution of each species in the various islands in 1908, 1921 and 1933 respectively. The book concludes with an extensive bibliography and excellent photographic plates.

THE CANINE CULT

Dogs in Britain

A Description of all Native Breeds and most Foreign Breeds in Britain. By Clifford L. B. Hubbard. Pp. xii + 471 + 8 plates. (London: Macmillan and Co., Ltd., 1948.) 21*s.* net.

GREAT BRITAIN, per head of population, contains more dogs in private ownership than any other country in the world. Dog-breeding in Britain is a big industry, dog-showing a bigger, dog-owning a passion. Yet there is a profound ignorance about dogs, about everything to do with dogs, in Britain. Too many people own dogs because it is 'the right thing' to do, and not because they either love them or understand them: too many people breed freaks because it pays to do so. It is, in fact, not far from the truth to say that we are a nation of dog-owners and not, as we like to make out, a nation of dog-lovers.

How near to the truth that statement is can be seen from a study of canine literature. There is a small but excellent specialist Press; there are a number of specialist booklets devoted to individual breeds: there is one encyclopædic volume at a high price, a price beyond the reach of most dog-owners: there is a vast assortment of illustrated literature of a popular and definitely sentimental type; and it has always been the same. There is, therefore, a great opportunity for an all-round book about dogs; one that does not sentimentalize; one whose illustrations do not portray the dog as something rather more than human, stressing its 'fetching' ways to the exclusion of all else; one that both entertains and instructs. Mr. Hubbard has seized the opportunity. His book, most reasonably priced, will meet a long-felt want.

This book is uniform with those two excellent volumes by L. J. F. Brimble, "Flowers in Britain" and "Trees in Britain", which means that it is lavishly illustrated in colour and half-tone, yet in rather less than five hundred pages the author has managed to cover almost every aspect of the modern dog-world. Origins, breeding, training, management, breeds and varieties, diseases and ailments, all are treated authoritatively but simply. Mr. Hubbard never becomes involved, never ceases to be anything but practical, never ceases to entertain. He has, too, the wide view. He is not content to deal only with the popular British breeds, but also gives details of many foreign breeds, few specimens of which are to be seen here, but which in their own countries are as popular as the cocker spaniel is in the English suburbs.

On the practical side—on breeding, training, management, and on the health and care of the dog—what he has to say, and the way in which he says it, is beyond praise. His chapter on the dog in literature and art (in which he had the assistance of Mr. Stuart Tresilian, who was also responsible for the beautiful coloured plates, and Mr. Stuart Raye) cannot fail to appeal to anyone with a fondness for dogs. All those who have at any time "given their heart to a dog to tear" will read this section again and again.

Mr. Hubbard will not, however, find universal acceptance for all his views on the origin of the dog, or for all he has to say on the very interesting (but surely, more complicated) subject of the wild dogs of the world. In particular, it is certainly over-simplifying matters to dismiss the pariah dog as semi-wild, if, by that, is meant feral. Pariah is a word that has come to be loosely used in English. That there are feral dogs infesting the Middle and Far East is beyond question; but there is also a quite distinct form (some authorities recognize two types) of truly wild pariah. These are matters, however, for the specialist with zoological leanings, and do not affect in any way the great value of the book for the non-specialist dog-owner and -lover.

But on another matter, of great concern to all dog-owners and -lovers, Mr. Hubbard has allowed his enthusiasm to run away with him. He speaks of dog specialists as "cynologists". He even goes so far as to describe Dr. John Caius, the learned founder of Caius College, Cambridge, as "the Elizabethan cynologist", and, further, to put the generic separation of dog and fox to the credit of advance in "cynological study". It was due, of course, to nothing of the sort. But it is the word that is disturbing. It has no place in the dictionary, and it should have no place in the world of dogs, for if it is to be accepted what are we to call the specialists in horses, cats, pigs, and other domestic animals?

Enthusiasm is, however, a good fault. To read this beautifully illustrated and produced book is to catch much of the author's enthusiasm. It should have, and will thoroughly deserve, a great welcome from the dog world, for there is no one—specialist no less than novice—who will not be the better for reading it.

BRIAN VESEY-FITZGERALD

RESEARCH SERVICES IN EAST AFRICA*

By Dr. E. B. WORTHINGTON
Scientific Secretary, East Africa High Commission

A PROVISION of the Colonial Development and Welfare Act of 1945 was to earmark up to a million pounds a year for ten years from the British Treasury for research in and on behalf of the Colonial Empire, and in consequence there has been much activity both at home and overseas in designing systems which will enable these funds to be spent in the best way. The purpose of this article is not to recapitulate the work at the London end, centred on the Colonial Office, because this is summarized in the published annual reports of the Colonial Research Committee (now Council) and other advisory committees and councils concerned, and has already been noticed from time to time in *Nature*. The object is to describe how the new system is working out in a Colonial region, with the advice and assistance of the London authorities.

For this purpose East Africa is taken as the example for several reasons. It comprises three contiguous territories, Kenya, Tanganyika and Uganda, with the island Protectorate of Zanzibar adjoining, so that its components do not suffer from separation by wedges of territory administered by a foreign power, as in the case of the West African region. East Africa has advantages over its neighbouring region of Central Africa, because all its component territories are ultimately responsible to the British Parliament through the Secretary of State for the Colonies, whereas Central Africa has to combine two such territories, Northern Rhodesia and Nyasaland, with Southern Rhodesia which has Dominion status and is therefore responsible only to itself and does not qualify for grant aid under the Colonial Development and Welfare Act. A further reason for taking East Africa as the example is that, in addition to the territorial Governments, there has been since April 1948 a form of regional Government, the East Africa High Commission, which has its own 'Central Assembly' and secretariat, and is directly responsible for a number of scheduled services, among which inter-territorial research and other scientific activities take a prominent place. The East Africa High Commission has a scientific secretary whose duties are specially concerned with creating a framework within which science can be pursued with a reasonable degree of freedom in the main subjects involved.

Inter-territorial research in East Africa may be said to date from the Ormsby-Gore Commission of 1924, as the result of which the old German scientific station at Amani in Tanganyika was developed into an Agricultural Research Institute having functions in the whole region. Many other Commissions, notably the Hailey Survey of Africa during 1934–37, emphasized the need for more research and for closer co-operation in research. Nevertheless, until the War, investigations were arranged mainly on the basis of technical departments of territorial Governments, within which very few officers could be sufficiently freed from routine duties to undertake research in the true sense. In addition to Amani, however, one or two inter-territorial institutions had been established, notably the Central Veterinary Research Institute at Kabete in Kenya, and the Tsetse Fly Research Institute at Shinyanga, which, though primarily headquarters of the Tanganyika Tsetse Department, operated in the adjacent territories as well. During the War, isolation of research workers tended to become more acute; but latterly visits from a number of men eminent in particular scientific spheres have resulted in recommendations, most of which have now been bound into a general scientific framework. The stage is set, therefore, for a big improvement in research, designed to provide a more adequate background of knowledge on which to base development in East Africa.

I would be the last to claim that what we have planned will be sufficient for more than a few years to come. It is significant in this connexion to compare the research plan for East Africa with that of a neighbouring region comparable in size, namely, the Belgian Congo. In the group of subjects concerned with primary production from the soil, the Institut National pour l'Étude Agronomique du Congo Belge has an annual subvention towards recurrent expenditure of more than a hundred million francs, 3 per cent or so of the whole expenditure on public services in the country. In addition, the Belgian Government has established in 1948 the Institut des Recherches Scientifiques en Afrique Centrale for long-term research in other subjects, with a capital sum of 450 million francs. By comparison, the expenditure on research in East Africa, including grant aid from Colonial Development and Welfare funds, is not expected to reach even 1 per cent of total public expenditure during the next few years. This suggests a scientific deficiency in the British as compared with the Belgian Colonial system which must be made good in course of time.

In the scheme for East African research the first principle being applied is to separate research from executive responsibility wherever possible. Much of the research is being arranged, therefore, in a series of organisations with functions extending over the whole region; and these will be advisory to the executive technical departments, such as those concerned with agriculture, veterinary work, forestry, tsetse control, public works, which will remain responsible to the separate territorial Governments.

The advantages of pooling a good part of the research effort in this way will be several: first, greater efficiency, including savings on capital expenditure and personnel; secondly, better recruiting prospects, because inter-territorial research organisations will offer wider scope to young scientific workers; thirdly, easier arrangements for seconding specialists to and from centres of research in Great Britain and the Dominions; and fourthly, better service to the territorial Governments and those interested in using the results of research.

Five inter-territorial research organisations are being established now, concerned with the following subjects: agriculture and forestry; veterinary science and animal husbandry; tsetse flies and trypanosomiasis; fisheries; scientific and industrial research. These do not cover by any means the whole field. They are restricted to the main pro-

* This article summarizes a fuller document on the subject which was laid on the table at the first meeting of the Central Assembly of the East Africa High Commission in April 1948.

ductive subjects, not because we attribute less weight to subjects of social importance, such as health, sociology and education, but because research on these is at present being arranged direct by the authorities at the Colonial Office, with the East Africa High Commission serving in the capacity of local agent rather than controlling authority. There are, however, several branches of research on social subjects of a long-range character attached to Makerere College in Uganda, which is tending to become the East African University.

It is not intended that every scientific man in East Africa will become part of an inter-territorial research organisation, because it will be necessary for each of the main executive departments, being part of the territorial Governments in each territory, to retain its own group of specialists for routine and advisory work. Whereas the research organisations are likely to initiate new lines of investigation, it is expected, moreover, that territorial departments will become intimately concerned as soon as a branch of research reaches the technological stage, when initial results require testing under a variety of practical field conditions.

The research organisations themselves will be responsible direct to the East Africa High Commission; but each will maintain close contacts on one hand with the territorial technical departments concerned, and on the other with the respective council or committee at the Colonial Office. Ultimately it will no doubt be necessary to have a hierarchy of councils and committees in East Africa, bringing a wide variety of experience to bear on the lines which research should follow. We are not starting with this, however, but are adopting the principle of not holding meetings unless there are important matters for discussion and decision. In practice, of course, many conferences and meetings have to be held, but the permanent system of advisory and executive bodies is being allowed to grow up naturally, following rather than preceding the initiation of actual research.

Certain principles apply to each of the five research organisations enumerated above, and to others which may be established. The concept of the 'Research Organisation' rather than the 'Research Institute' is important as implying that the work will pervade the whole of East Africa and not be concentrated in one building. In each case a headquarters of the organisation is being established at some convenient place, and some activities involving extensive facilities and costly apparatus will inevitably take place at headquarters. But the headquarters will be easy to get away from as well as to reach; and the object of each research organisation will be to conduct research on behalf of East Africa wherever it can be pursued most efficiently. This may be at a scientific centre in Great Britain or a Dominion, at the headquarters of the organisation in East Africa, at a territorial laboratory or out-station, or in a tent in the bush. Another important point is that our research organisations will be staffed by members of the new Colonial Research Service which is expected to be inaugurated in the near future. The terms of service will involve contributory pensions, so that staff will be transferable without difficulty to and from scientific centres elsewhere, particularly those which subscribe to the F.S.S.U.

Considering the five research organisations in more detail, their designation by initials seems inevitable, and in each case the subject is preceded by E.A. (East Africa) and followed by R.O. (Research Organisation). The largest is E.A.A.F.R.O. (Agriculture and Forestry), which is directed by Dr. B. A. Keen, and will have also Dr. H. H. Storey, who is returning to active research in Africa after valuable work as secretary for agricultural research at the Colonial Office. This organisation, which will absorb the existing staff and facilities at Amani, is intended to grow during five years to more than forty qualified men of science and a similar number of other European staff. Its main divisions will be concerned with soils, fertilizers, crops and pastures, pests and diseases, animal husbandry, sylviculture and forest products. A new headquarters is to be established at a convenient site in a healthy climate some fifteen miles from Nairobi, where a thousand acres of good land have been made available for the purpose by the Kenya Government. In addition, it is intended to have outstations distributed through East Africa, ultimately one in each main ecological zone, using where possible the existing agricultural and forestry experimental stations of the territorial departments. One section, concerned with taxonomic botany, will have special duties associated with the Royal Botanic Gardens at Kew in helping to prepare a much-needed Flora of East Africa, and the main herbarium will be established at the Coryndon Museum in Nairobi, where it will be easy for reference. For the initial capital expenditure on E.A.A.F.R.O., some £280,000 are being made available from Colonial Development and Welfare Research funds, and the aggregate recurrent expenditure for the first five years is estimated at £297,000, of which £165,000 is likewise to come from Colonial Development and Welfare Research funds, the balance being subscribed by the East African Governments.

Next in the list is E.A.V.R.O. (Veterinary), directed by Dr. E. G. White. In staff this will grow to about half the size of E.A.A.F.R.O. It is concerned with all aspects of animal disease, animal health and husbandry, and the production of biological products, which is already a service extending through a good part of the African continent and elsewhere. A part of E.A.V.R.O. concerned with disease is developing from the former Central Veterinary Research Institute and will continue to be located at Kabete, near Nairobi, where additional buildings are being erected. A new part, concerned with animal husbandry, will have headquarters side by side with those of E.A.A.F.R.O., seven miles from Kabete. Capital expenditure on this organisation is expected to be £125,000 provided from Colonial Development and Welfare Research funds, and recurrent expenditure for the first five years about £399,000, £94,000 coming from Colonial Development and Welfare Research funds, £80,000 from the East African Governments and the balance from the sale of biological products.

E.A.T.T.R.O. (Tsetse and Trypanosomiasis) is at present in two sections. Tsetse research is based at Shinyanga in Tanganyika, in charge of Mr. W. H. Potts, with a staff of ten scientific workers and a similar number of other Europeans; human trypanosomiasis research is some thirty-five miles away Tat inde in charge of Dr. H. Fairbairn, with three men of science. Expenditure for the next five years is estimated at £218,000, of which two-thirds is voted from Colonial Development and Welfare Research funds and the balance provided by the East African Governments. These two centres have been in existence for many years, and some reorganisation is expected, including the binding

together of the tsetse and trypanosomiasis research with the separate department of Experimental Tsetse Reclamation, which is in charge of Mr. Napier Bax.

E.A.F.R.O. (Fisheries) is at present quite small, dealing only with research on lakes and rivers. Its director is Mr. R. S. A. Beauchamp, who will have four or five scientific workers on his staff, and the headquarters are at Jinja in Uganda, at the point where the Nile originates from Lake Victoria. Capital expenditure of £64,000 and recurrent expenditure for five years of £51,000 are provided in whole from Colonial Development and Welfare Research funds. It is hoped that a fisheries research unit will soon be added for the marine waters of East Africa, and there is also recently established in Kenya a small station on the slopes of Mt. Kenya for investigating the special problems of streams and trout fisheries.

E.A.S.I.R.O. (Scientific and Industrial) will, it is hoped, be one of the most important of the research organisations, its subjects including buildings, roads, secondary industries, food processing and water pollution. Only a part of it yet exists, the East Africa Industrial Research Laboratory, situated in Nairobi, in charge of Mr. H. B. Stent. This organisation is intended ultimately to form a kind of local counterpart of the Department of Scientific and Industrial Research in Great Britain. Clearly, it will not be able to undertake extensive researches of a fundamental character except in special cases which demand proximity to local conditions. Wherever possible, problems arising in East Africa would be passed on to larger centres of research such as those established in Britain by the Department of Scientific and Industrial Research.

There are many scientific subjects of importance to Colonial development which are not covered by these research organisations. To mention a few: meteorology is looked after by the East African Meteorological Department, which includes research in its purview wherever it can be fitted in with the regular activities of recording and disseminating information. Hydrology is another subject of basic importance, and the beginnings of its study on a regional basis exist in a newly established hydrological survey of the Nile Basin within East Africa, necessary in connexion with the project for converting Lake Victoria into the largest reservoir in the world. Geology is still a function of territorial departments which, however, are coming into closer line with each other, aided by annual conferences which have been inaugurated in 1948. The same applies to work on the fauna, for which again annual meetings between game wardens have been started. There is much research progressing on insecticides with particular reference to their use against tsetse flies, this being the responsibility of the Colonial Insecticides Committee in London, which maintains a research unit in East Africa and is initiating a series of trials with aircraft in 1948. The problem of locusts is another subject on which research in East Africa is part of a wider service, in this case international in character. Archæology, in which East Africa has outstanding wealth, still awaits more extensive and more permanent facilities. Finally, there is great need for research on economics and statistics, and the East African Statistical Office, which, like the research organisations, is responsible to the East Africa High Commission, is already in existence and likely to expand.

SCIENTIFIC ASPECTS OF COLONIAL DEVELOPMENT

THE president of the British Association for the Advancement of Science, Sir Henry Tizard, referred in his inaugural address at the Brighton meeting to "our bounden duty, and the only certain way of safeguarding our future so long as we remain a large food-importing country, to develop our Colonial territories, particularly the under-populated African colonies, where the increase in population that would follow the control of disease and the increase of food supply would open fresh markets for international trade". The president of Section E (Geography) of the Association, Lord Rennell of Rodd, speaking of "Geography as a Social Science, with special reference to Africa", said, "For our own good name, the social geographer must be called on to play his very large part in adapting our changing conceptions of African administration, and in seeking to rationalize the mess which western European nations, including we ourselves, have made in the African continent". His address was followed by a discussion in Section E on the scientific aspects of colonial development, to which a number of the younger geographers, several with experience of work and conditions in the Colonies, contributed. While recognizing that geography is only one of many sciences which could be, and must be, applied to the problems of the Colonies, the geographers were all agreed that their subject has a very definite and distinctive contribution, though one which has not hitherto been given adequate recognition by those in authority.

As to the nature of the contribution, there was considerable discussion. Some believed in the existence of a 'colonial geography', recognized, according to one speaker, by the governments and universities of all the Colonial Powers, except Great Britain, and particularly by France and the Netherlands: but a majority emphasized that colonial territories call for precisely the same type of geographical investigation as any other part of the world, and that the geographer's particular task is the study of the regional characteristics of different areas. Such a study requires the correlation of numerous branches of science, ranging from geology to social anthropology. One speaker recommended the formation of a single colonial institute, forming a part of one of the Universities of Oxford, Cambridge or London, which would not only be responsible for the training of administrative and technical officers for the Colonies but also would undertake, or be cognizant of, colonial research in most, if not all, branches of knowledge. In an institute of this type, the geographer, with his interest in widely different aspects of environment and society, would have an important role. Another speaker suggested that insufficient use is made at present of the very considerable geographical knowledge of officials and others who have lived for long periods in the Colonies.

Lord Rennell described geography as "both the science and the art which deals with mankind on the earth on which we live". It studies in particular the interaction of physical facts on one hand, and economic, social and political conditions on the other. The influence of physical environment upon human activity is generally most noticeable among more backward people—though even here there is no such

thing as 'environmental control'; and it is, therefore, particularly appropriate that geographers should concern themselves with tropical regions. Increasingly it is being recognized that the economic development of the tropics cannot come about except by the conquest of disease, the raising of standards of living, and the institution of comprehensive programmes of drainage and irrigation, road-building and port development. The blind belief in the inherent fertility of the tropics has at long last disappeared: and projects like the groundnut scheme in East Africa can succeed only after the most careful study of the facts of geology and topography, temperature and rainfall, natural vegetation and soil types. These facts are rightly studied by specialists—by geologists, meteorologists, plant ecologists, soil scientists, and the like. Too often, though, the interactions of these facts are inadequately considered, since they lie in the province of no particular specialist: and it is here that the geographer believes that he has a place in the scientific hierarchy, since by the nature of his training he is specially equipped to look out for interconnexions. He is not content with the facts of either geology or meteorology or botany, taken by themselves, in any particular area. He wants the complete picture—made up of physical conditions and human responses—or, as he puts it, the 'regional geography'.

The work of many of the economic and other missions to British Colonies in recent years would have been greatly facilitated if less time could have been spent in fact-finding, and more attention paid to the elaboration of concrete development programmes. Had the regional geography of British Colonies been studied as fully as that of, say, France—or even as inadequately as that of Great Britain itself—these missions would have had at least a basis on which to build. As it is, the regional geography of the Colonial Empire remains unwritten, apart from the isolated work of pioneers such as Clement Gillman in Tanganyika Territory. In this connexion the new colonial universities and colleges have an important contribution to make to our geographical knowledge of the world.

More than one speaker stressed the need for a colonial atlas, in the preparation of which geographers would take a prominent role: such an atlas would include distribution as well as topographical maps. The French and Dutch colonial atlases were quoted as excellent examples, and reference made to the successful efforts of Section E of the British Association in pushing forward the preparation of a National Atlas for Great Britain. It was suggested that as a first stage, maps might be prepared for groups of British territories, full use being made of the technique of mapping from air photographs and of the resources of the Directorate of Colonial Surveys.

Lord Rennell concluded by stating that facilities are now available for geographers to an extent never known before, and that the Colonial Office has recently asked specifically for trained geographers for research investigations in the Colonies. It is now open to geographers to make as effective a contribution to the study of the problems of colonial development as they have made at home, through the Land Utilisation Survey and in other ways, to the problems of agriculture and of town and country planning. Their fellow-scientists will judge the validity of the geographers' claim by the quality of their work in the colonial field and by the distinctiveness of their contribution.

NATURE OF INCENTIVES

AS might have been expected, the discussion of 'incentives' in the meeting at Brighton of Section J (Psychology) of the British Association afforded yet another opportunity for attempting to define the nature and extent of the responsibility of scientific workers for industrial efficiency. From various points of view, industry was challenged to try out new techniques and policies of management, and men of science were challenged to develop new concepts and procedures in the organisation of research.

Mr. Nigel Balchin, who opened the symposium, expanded his now well-known thesis that under present social conditions the traditional incentive of financial rewards has broken down, and that in future industry must rely upon entirely different motives for the maintenance of optimum effort. "If we have," he said, "on one hand a perfectly reasonable demand for a high material standard of life, which can only be supplied by productive effort, and on the other an equally reasonable demand for happiness in activity, the only possible solution is *to make work the happy activity*." Since we do not yet know how this is to be done, the first responsibility of the man of science is to engage in research into basic principles. Psychologists should stop 'trying to run other peoples factories' and concentrate on research into general principles.

The main themes of the second paper (that of the present writer) were in more than one way complementary to those of Mr. Balchin. There is, of course, much that we do not know; but, it was argued, there is also much that we know well enough but do not act upon. Research in this field, the results of which would be applicable, cannot be conducted entirely outside the factory but depends on close collaboration between scientific workers with more than a superficial knowledge of industrial administration and managers with more than a superficial knowledge of scientific method. One field in which such collaboration would be especially fruitful, both in the application of existing knowledge and in the promotion of fresh research, is that of 'target setting' both on a national scale and in the detailed procedures of time and method study. Evidence of the ripeness of this particular harvest could be adduced from recent trends of thought in scientifically minded exponents of time-study procedures and from the increasingly open-minded and experimental mood of industry itself in this regard. *Target*, the monthly bulletin of production publicity of the Central Office of Information, is full of reports of new incentive experiments, the results of which should be well worth scientific observation and assessment.

Following up a point first made by Mr. Alec Rodger in the conference at Leamington of the Division for the Social and International Relations of Science of the British Association, it was further suggested that among the preconditions of the effective application of existing technical knowledge is the application of existing knowledge of another kind—of principles governing human relations in industry, on which there is a surprising unanimity of opinion among moral philosophers, political reformers and religious teachers of every school, party and sect. For example, the often quoted precept of Immanuel Kant that "every man should be treated as an end and not merely as a means" is one that in principle admits of translation into scientific terms and into

terms of industrial practice. So translated, it might be worth submitting to tests acceptable to the statistician and methodologist as theoretically sound, and acceptable to management as workable in practice.

An even more fundamental challenge to science and management would seem to have been implied by the argument of the third contributor to the symposium. According to Mr. Adam Curle, who approached the subject from the point of view of an anthropologist, the very existence of an incentives problem is symptomatic of a malady in modern society. In primitive societies necessary work is as automatic as eating or sex; and our present problem is nothing less than that of recreating these conditions. This, of course, is not to be achieved by a mere regression to the original order. The need is for a new social order "in which the anxious tensions resulting in withdrawal and isolation from the group can be reduced". We need to provide the conditions of a 'psychological' as well as those of a constitutional democracy. Then the incentives problem would again disappear. Nothing very specific was suggested as to the way in which this might be done; but it would depend on close collaboration between social scientists of many different kinds. The results obtained in army resettlement units, it was suggested, gives some indication of the lines along which to work.

Mr. Alec Rodger, through what at first appeared to be an excursion into lexicography, raised an issue of the greatest moment. The term 'incentive', he pointed out, is commonly used by industrialists and defined in dictionaries by reference to incitements that are essentially passing rather than permanent in effect. On the other hand, the preceding speakers had appeared to be almost exclusively concerned with the conditions that continuously maintain an optimum level of effort throughout the working weeks and years. "Admittedly we need long-term programmes for the improvement of morale, for in the long run this is the only manner in which high industrial productivity is likely to be properly established and sustained; but in our present plight we cannot disdain to use any device which shows promise of yielding quick results." An example of the sort of research which was needed was quoted from some studies of the Social Survey which had given indications that different types of motivation operate at different intelligence levels.

Speaking with intimate and first-hand experience, Mr. Rodger had things to say on the functions of the psychologist in relation to management and administration. The root of the problem, he suggested, lies in the fact that the technical adviser will often miss the opportunity both to understand the principles on which his colleagues work and of dealing with critical situations unless at the decisive moment he is prepared to do the job himself, since he can act with insight and confidence when they cannot.

The discussion as a whole, however inconclusive and however limited in suggestions likely to yield 'quick results' it may have seemed, served a useful purpose in revealing something of the total dimensions of the problem. There is clearly, and by general agreement, a need for expansion and intensification of research and development in which a due balance is preserved between the advance of knowledge and the application of what is already known. There is need for advances both in fundamental research and in the development of practical techniques. It is probably through the development of managerial techniques for using what is already known that the 'quick results' are most likely to be obtained. But it is here, more than anywhere else, that Mr. Rodger's distinction needs to be kept in mind. There is a widespread view among industrial psychologists that the benefits derived from temporary incitements are often paid for dearly through their subsequent effects in fatigue and reaction. If they be correct in this opinion, the use of such expedients can be defended only in an emergency the passing nature of which can be predicted with some assurance. Here, as elsewhere, the best results are likely to be achieved by those who combine a sense of the need for quick results with the wider and the longer view. Perhaps this combination is not to be found in any single scientific or managerial group; and the need will only be met by the kinds of collaboration concerning which all the speakers were agreed. It is accordingly somewhat sobering to reflect that in spite of the widespread interest in the problem, the number of workers actually engaged in relevant research at this time is extremely small.

C. A. Mace

TRANSMISSION OF EFFECTS FROM THE ENDINGS OF NERVE FIBRES

A DISCUSSION on the transmission of effects from the ends of nerve fibres occupied an afternoon session of Section I (Physiology) of the British Association on September 9. Sir Henry Dale introduced the discussion by saying that we may agree on the assumption that the liberation of one or another chemical substance with a specific stimulating action is the means by which, in vertebrates, nerve impulses are transmitted from the endings of all efferent fibres of the peripheral nervous system, whether pre- or post-ganglionic fibres of the involuntary nerves, or motor fibres of the voluntary nerves. But there remains a wealth of problems still open to discussion concerning details of such a process.

Since two of the speakers were dealing with the extension of this theory to the vast complex of synaptic junctions in the central nervous system, Sir Henry Dale first discussed this problem. The exciting possibilities presented by studies in this field, he said, have acted as both a stimulus and a deterrent. When, more than twenty years ago, he told Sir Charles Sherrington, then already in retirement, about the evidence that had been obtained at that time in his laboratory for the transmitter function of acetylcholine at preganglionic and voluntary motor nerve endings, Sir Charles' immediate reaction was to insist that a process observed at peripheral synapses must furnish some kind of analogy for events at those of the central nervous system. Referring to the experimental attempt of Dr. W. Feldberg to distinguish central synapses at which transmission may be cholinergic from others at which it is not, Sir Henry Dale said that such a differentiation raises the question as to what the transmitter may be at these others. For it is difficult to suppose that synapses in the central nervous system can differ among themselves so fundamentally in function that transmission at some should be cholinergic and at others involve no kind of chemical agent. Referring to the experiments of Mr. J. W. S. Pringle and Mr. G. M. Hughes, by which the discussion is extended to the nerve ganglia of the ventral chain in an insect, he again pointed out

that we should scarcely expect to find that the transmission across synaptic junctions in an insect's ganglion would involve a process fundamentally different in kind from that which is effective at vertebrate synapses.

Turning to the recent developments of evidence for the nature of the transmitter substances themselves in the peripheral vertebrate system, Sir Henry Dale discussed several outstanding and very acute problems in this field of research. For cholinergic transmission the released agent is acetylcholine itself, but there has never been the same certainty with regard to the transmitter of adrenergic fibres, adrenaline. "This problem has recently acquired a new aspect through the evidence produced by U. von Euler, that the sympathomimetic agent extractable from sympathetic nerves or from the spleen, appears, indeed, to be chiefly *nor*-adrenaline rather than adrenaline, and Gaddum's finding that the substance released in the spleen when its adrenergic nerve is stimulated is likewise, for the most part, the primary amine. One is tempted to speculate whether a renewed investigation of the suprarenal gland might not reveal *nor*-adrenaline as a constituent of its medulla as well as its long known *N*-methylated homologue, adrenaline." We should further keep in mind that the list of the transmitters, even at the peripheral cytoneural junctions, should not yet be regarded as finally restricted to the two concerned with the recognized cholinergic and adrenergic processes of transmission. Histamine may have to be considered as contributing, at least, to the so-called antidromic vasodilator effect, a possibility envisaged by Lewis and his co-workers and supported by evidence from Ungar and others.

The next problem taken up concerned the presence of the transmitter substances and the relevant enzymes for their synthesis and destruction along the whole course of a nerve fibre. According to Sir Henry Dale, it does not seem possible to accept the suggestion so vigorously urged in recent years by Dr. Nachmansohn and his associates. According to these speculations, acetylcholine would not only be responsible for the transmission from nerve ending to a secondary neuron or an effector cell, but also for the propagated nerve impulse along the nerve fibre. "Such a conception offers, of course, the kind of intellectual satisfaction which many minds obtain from a simplifying and co-ordinating generalization. There is, however, a remarkable lack of unequivocal evidence to support it directly, while the ingenuity of its supporters is sorely taxed to discover even plausible ways of escape from the facts which contradict it." Only some nerve fibres are cholinergic. The theory postulates a stimulating depolarizing action of acetylcholine on the nerve fibres. But as Lorenté de No has shown recently, the nerve fibre in continuity is as indifferent to acetylcholine-chloride, even in isotonic solution, as to cane sugar, provided only sufficient physostigmine, or other anti-cholinesterase, is added, to prevent the esterase in the nerve from hydrolysing the acetylcholine, and thus liberating acetic acid ions from it in a harmful concentration. We may, however, have to consider the possibility, put forward with all reserve by Sir Henry Dale, that the transmitter which we find distributed along the fibres represents a kind of reserve needed for the regular and immediate replenishment of the depots at the endings, and that the passage of impulses along the fibres to their endings would somehow facilitate a drift of the transmitter down them in the same direction.

The last problem dealt with by Sir Henry Dale concerned the presence or absence of the transmitter substances, not along the nerve fibres, but in the protoplasma or neurosoma of the nerve cells themselves from which the axons in question originate.

Prof. F. R. Miller, of the University of Western Ontario, then described his discovery of the central stimulating actions of acetylcholine and eserine, effects which are consistent with the suggestion, made so early as 1934 by Sir Henry Dale, that acetylcholine may be concerned in the transmission at central synapses. Even in the experiments with eserine, acetylcholine is probably the actual stimulating agent, because the central actions of eserine, like its peripheral ones, are also probably more or less fully accounted for by its power of inhibiting cholinesterase, the enzyme which destroys acetylcholine, thus leading to its accumulation at the synapses.

The technique adopted by Prof. Miller in these experiments consisted in soaking small pieces of filter paper in a solution of acetylcholine or eserine and applying them to the cerebral cortex of cats and rabbits. Eserine applied in this way to the centres for the fore- or hind-limbs evoked within a few seconds motor effects of rapidly increasing intensity in the corresponding limb of the opposite side. The cortical electrogram was modified. The normal large slow waves were replaced by small fast waves suggesting an asynchronous firing of cortical neurons. Acetylcholine similarly applied to a previously eserinized cortex induced large 10 per second spikes in the cortical electrogram, together with motor effects in the muscle units, as shown with the cathode ray oscillograph by Miller, Stavraky, Woonton, Wilkey and Luke. According to Miller, each 'acetylcholine spike' suggests a synchronous firing of a number of cortical neurons under the influence of "cells with short axons", each of which controls a number of pyramidal cells.

Particularly striking were more recent experiments in which Prof. Miller applied dilute solutions of acetylcholine, with the same technique, to the floor of the fourth ventricle. These experiments were performed on decerebrate cats which had received an injection of eserine. The local application of acetylcholine stimulated the inspiratory centre, and later on caused convulsive discharges from the hypoglossus nucleus, shown by powerful retractions of the tongue. These effects, like the comparable stimulating actions of acetylcholine on the spinal cord, described by Bülbring and Burn, were abolished by atropine.

Dr. W. Feldberg remarked that he approached the problem of central synaptic transmission by acetylcholine in a different way. Miss M. Vogt and he studied the synthesis of acetylcholine in various relatively small but well-defined areas of the brain and medulla. An analysis of the distribution of the enzyme system responsible for the synthesis of acetylcholine in the central nervous system led them to the conclusion that acetylcholine is not the universal central synaptic transmitter, and that often, although by no means always, the arrangement of neurons in the afferent and efferent nervous pathways is such that cholinergic and non-cholinergic neurons alternate with each other. For example, in the voluntary motor pathway, the finding of a high enzyme concentration in the anterior horns, the motor nuclei of the cranial nerves and the anterior roots suggests the cholinergic nature of the lower motor neuron. On the other hand, the

low values encountered in the pyramidal tracts indicate that the upper motor neuron is not cholinergic. In the motor area of the cerebral cortex an intermediate value was found. This might suggest that cholinergic neurons converge on the pyramidal cells. Similarly, the low values found for the posterior roots and their central continuation, the funiculi gracilis and cuneatus, are in agreement with the conception that the first neuron of the afferent sensory pathway is non-cholinergic. However, the relatively high values obtained for the nuclear masses in which these sensory fibres end might be evidence for the cholinergic nature of the second neuron in the sensory pathway.

The third neuron, originating in the thalamus and leading to the cortex, is probably non-cholinergic, as suggested by the low values found for the fibres in the posterior parts of the internal capsule, which at least in man is said to contain the thalamic radiation. Another example was provided by the optic pathway. The retina contains large amounts of the enzyme which synthesizes acetylcholine, whereas the optic nerve is practically free from it. This suggests that acetylcholine is the chemical transmitter at one or more of the synaptic junctions in the retina. Among these junctions may be that to the ganglionic layer from which the non-cholinergic optic nerve originates. The optic fibres end mainly in the lateral geniculate body, and the high enzyme values found for this region may indicate a cholinergic nature of the third neuron in this pathway. Dr. Feldberg stressed the fact that, however attractive such a pattern of a succession of alternating non-cholinergic and cholinergic neurons may be, it would be dangerous to have a conception which is too simplified and diagrammatic. We must realize that if there are two different kinds of neurons in the central nervous system, then on purely statistical grounds there should be a great incidence of such an alternation.

The great number of problems involved in the process of central synaptic transmission and their complexity were brought to light by beautiful experiments on cockroaches reported by Mr. J. W. S. Pringle and Mr. G. M. Hughes. They had passed weak polarizing currents laterally through the metathoracic ganglion of the cockroach. This affected the flexor-extensor balance in such a way that the leg on the negative side flexed while that on the positive side extended. With longitudinal stimulation, ascending currents flexed the legs on both sides of the cockroach and descending currents encouraged extension. It is interesting that Skoglund had observed similar reaction patterns in corresponding experiments on cats. Mr. Pringle and Mr. Hughes suggest that the weak polarizing current excites internuncial fibres and not the motoneurons, because preparations in which only a single nerve was left attached to the ganglion did not show this differential effect when the polarizing current was applied between ganglion and nerve. In these preparations the negative electrode on the ganglion excited, and the positive inhibited, any resting discharge in the larger motor fibres, irrespective of whether the nerve supplied flexor or extensor muscles.

Concerning the problem of chemical transmission, they pointed out that the evidence available shows that the motor nerves to the muscles are not cholinergic in the Arthropoda. On the other hand, acetylcholine may well have a transmitter function at the central ganglionic synapses, because its application to these ganglia causes a discharge of impulses in the motor nerve fibres. It is further possible that the differential effect of polarizing current is due to the fact that in Arthropoda, as in other organisms, two types of transmitter substances are involved in central synaptic transmission.

At the end of the meeting, Prof. R. J. S. McDowall showed a few slides from his recent experiments on the rat's diaphragm preparation, in which he had obtained a curare-like block of neuromuscular transmission as an effect of lack of glucose.

OBITUARIES

Dr. William Cullen

By the death, at the age of eighty-one, of Dr. William Cullen, a prominent figure and a vivid personality has been lost to a wide circle of men actively engaged in the varied pursuits which are related directly and indirectly to chemical technology, to metalliferous mining and to metallurgy.

It would be difficult to enumerate the manifold activities with which his name has been identified over the past fifty years; but these are happily recorded, for the most part, in the numerous papers and addresses which he had contributed to the various scientific and technical bodies with which he was associated. His earlier work was published under the auspices of the Chemical, Metallurgical and Mining Society of South Africa, of which he became president in 1905. In later years, the *Transactions of the Institution of Mining and Metallurgy*, *the Institution of Chemical Engineers* and *the Society of Chemical Industry* have been enriched by his contributions. By each of these bodies in turn he was elected to the presidential chair.

Dr. Cullen's life-work can be divided into two periods. The first was that of his earlier work in South Africa, commencing with his appointment, in the later stages of the 1899–1902 War, as general works manager, at Modderfontein, of the British South African Explosives Co. While retaining his close association with South African affairs to the end, particularly in regard to educational matters, the second period of his career dates from the time of his return to Great Britain in 1915, when, in association with the late K. B. Quinan and W. McNab, he was entrusted by Lord Moulton (then directing the Department of Explosives Supply) with the design and lay-out of new explosives factories called for by the exigencies of the First World War.

A Scotsman, reared in the hard school of the west coast and the Clydeside, Cullen received his early training in Glasgow, successively at Hutcheson's Grammar School and at what was then the Andersonian College (now the Royal Technical College). As a chemist, he became a member of the staff of Nobel's and later of Kynochs. It was this early experience of the chemistry of explosives that fitted him for the very prominent part he was destined to play in the vast developments which occurred in the mining industry in South Africa following the termination of the War of 1899–1902. The necessity had already been recognized and to some extent met, for the independence from outside supplies of industrial explosives, and it fell to Cullen's lot to promote this independence in step with the growing and pressing demands.

In these surroundings Cullen found scope for his wider interests and inherent sympathies. The admirable spirit of co-operation, and the refreshing freedom from secrecy regarding experience and knowledge of technical matters, which he found to exist among those directing the mining industry were fully in accord with an outlook which may be regarded as one of his happiest characteristics. Two matters in particular caused him grave concern. First, the appalling mortality, at that time, among those engaged in underground mining, and secondly, the widespread neglect to provide technical training for the younger members of the community. To both these problems Cullen gave unremitting thought and attention, which persisted, in one form or another, to the end of his life.

As the direct outcome of his own responsibilities, Cullen sought for more precise information regarding the nature of the gases resulting from the explosives which, at that time, were in general use underground. The previous neglect of this aspect of blasting operations was attributed by Cullen to a lack of contact between the manufacturers and the users of explosives, but "there," he said in one of his addresses, "we lived next door to each other." The results of the investigations, with relatively crude appliances and despite the serious hazards which close sampling involved, shocked them all. Ready, as he always was, to face up to unpalatable facts, he pursued these investigations in collaboration with his colleagues, T. Donaldson, E. Weiskopf and W. Waters. Discussions, following the publication of their results, lasted many months. Public conscience was aroused, and the Government took note. A commission was appointed (at which Cullen was an important witness) and the matter was followed by further work.

Although these inquiries did not attempt to go to the root causes of silicosis, as subsequent work has done, they, nevertheless, did much towards eliminating the hazards of poisoning from carbon monoxide and the oxides of nitrogen by establishing on a firm basis the need of an 'oxygen balance' in regard to all explosives used underground. Cognizance of this important requirement was taken all over the world. At the same time, Cullen was not unmindful of the unsolved problems of ventilation in mines; and the stimulus thus given to the need for greater attention to this matter has helped towards the immense advances which have now been made in this direction.

In regard to education and training, both in South Africa and in Great Britain, Cullen lived to see many of his cherished hopes and aspirations realized. As a member of the original Transvaal Council of Education and as an active participant in the work of the Transvaal Technical Institute, he helped to pave the way for the foundation of the University of the Witwatersrand. Recognition of these services was made in 1925, when the University conferred upon him the honorary degree of LL.D. He continued to represent the interests of the University in Great Britain. Of many ways in which he sought to promote its welfare, perhaps the outstanding service was the part he played, under the chairmanship of the Earl of Athlone, in making good, so far as possible, the losses sustained by the Library of the University as the result of the disastrous fire on Christmas Eve of 1931.

In addition to his unremitting services on the councils of those institutions and technical bodies over which he had in turn presided and of which he was later elected to honorary membership, he was an indefatigable lecturer and speaker on matters which came within his wide experience. As recently as 1944 he was called upon to preside over the deliberations of the Science Masters' Association.

Such were the activities of a man of far-seeing vision and buoyant disposition with a unique experience of men and affairs, one who has left a mark on generations of chemical technologists, mining engineers and metallurgists, and one to whom they could look with confidence at all times for guidance, encouragement and enduring friendship.

S. W. Smith

Sir Thomas Crozier

Major Sir Thomas Henry Crozier, formerly His Majesty's Chief Inspector of Explosives at the Home Office, died at Folkestone on September 26 at the age of eighty. Born at Monkstown, County Dublin, on February 26, 1868, he was educated at the United Services College, Westward Ho, and the Royal Military Academy, Woolwich, and was gazetted to the Royal Artillery in 1888. He held the posts of chief instructor in ammunition and explosives at the Ordnance College and afterwards chief instructor in artillery at the Royal Military Academy. He retired from the Army on April 17, 1908, when he was appointed one of His Majesty's inspectors of explosives at the Home Office.

On October 5, 1914, he rejoined the Army and served in "A" Battery of the 58th Brigade, Royal Field Artillery, 11th Division, Mediterranean Expeditionary Force. He was eventually invalided, and on recovery and after urgent representations by the Home Office owing to the greatly increased pressure of work, he rejoined the Explosives Department of the Home Office in October 1915. On February 12, 1926, he was appointed His Majesty's chief inspector of explosives. His work was rewarded on June 3, 1930, by the conferment of a knighthood. He retired on March 30, 1931.

During Sir Thomas's term of office in the Explosives Department, low-freezing explosives were introduced into general use in Great Britain, and the Petroleum Act, 1926, and the Petroleum (Consolidation) Act, 1928, were passed. Regulations were made for the conveyance by road of petroleum spirit, carbon disulphide and for the 'permanent' gases compressed in a metal cylinder. He was associated with a number of committees dealing with petroleum, dissolved acetylene, fire extinguishers, permitted explosives, classification of explosives used by the Fighting Services, carriage of dangerous goods in ships, welded containers, and cylinders for permanent and liquefiable gases. During the years 1927 and 1928, in conjunction with the late Prof. J. S. S. Brame, he carried out, on behalf of the Minister of Transport, a public inquiry into the modifications of the petroleum spirit by-laws proposed to be made by the Port of London Authority.

During the Second World War, the work of the Explosives Department increased considerably and, in consequence, Sir Thomas Crozier was asked to rejoin the Department, which he did on June 1, 1940. He relinquished this temporary appointment on September 30, 1944, owing to ill-health.

NEWS and VIEWS

Prof. F. E. Fritsch, F.R.S.

AFTER forty-one years as head of his Department, Prof. F. E. Fritsch retired from the chair of botany, Queen Mary College, London, on September 30, in his seventieth year. Though scarcely expected in boyhood to live to twenty, his already long and remarkable career has been an arduous one, its keynote continuous application sustained by a powerful sense of the absolute value of knowledge and work. In 1905, during his first appointment as assistant professor (1902–10) at University College, London, he obtained his D.Sc. (London), started a year's additional work at Birkbeck College and completed with Boodle the well-known translation of Solereder's "Systematic Anatomy". In 1907, when Queen Mary College (then East London College) was first recognized as a school of the University of London, he was appointed to take sole charge of the newly initiated Botany Department, becoming in 1910 its full-time professor with one assistant. His eight years collaboration with Salisbury from 1912 onwards resulted in the five familiar and ubiquitous joint text-books, and were shortly followed by his appointment to the University chair. His large and continuous output of contributions to algal and other botanical literature, even including the re-writing of West's "British Freshwater Algæ" which appeared revised in 1927 and the production of his largest work, "The Structure and Reproduction of the Algæ" (2 volumes, 1935 and 1945), though testifying to his unremitting industry, betray only a fraction of the activities he found possible concurrently with routine work and the steady development of his Department, which were rewarded in 1932 by election as a fellow of the Royal Society. He took an active share in the foundation in that year of the British Freshwater Biological Station at Wray Castle, on the Council of which he has acted as chairman ever since. His gift for diplomatic organisation and management has rendered him invaluable on numerous committees, including the Library, Scholarships and Central Research Fund Committees of the University of London.

To Prof. Fritsch himself this milestone of retirement will make comparatively little difference. Mentally vigorous as ever and still looking forward, he will continue to act on all these Committees in London, and by the courtesy of Prof. F. T. Brooks and his successor, Prof. G. E. Briggs, he is being enabled to continue his algal work in highly congenial surroundings at the Botany School, Cambridge. His friendly personality, equable disposition and philosophic outlook have ever made him an entirely congenial colleague. With his retirement Queen Mary College loses its longest servant, and the whole staff will miss the cheerful presence of an esteemed personal friend.

Wave-lengths for Broadcasting

FOLLOWING the meeting held by the International Telecommunications Union in Atlantic City in 1947 (see *Nature*, May 29, 1948, p. 863), a series of subsidiary conferences is being held in various parts of the world to deal with the allocation of radio wave-lengths for various purposes. According to *The Times*, a three-months conference in Copenhagen has just reached agreement on a new plan for the distribution of the long and medium wave-bands for European broadcasting stations. The new convention, which has been signed by twenty-five countries, will come into effect in March 1950, and will mean that many of the B.B.C.'s transmitters will have to change their operating frequencies. The allocation of short waves for sound broadcasting purposes will be decided by a conference which is to meet at Mexico City on October 22.

The last effective plan for the allocation of broadcasting wave-lengths to the European countries was made at Lucerne in 1933 (see *Nature*, December 2, 1933, p. 848, and January 20, 1934, p. 94); since then, the claims of some countries, particularly those which were less technically advanced at that time, have greatly increased. But the number of wave-length channels available has not increased, and so agreement on a new allocation has only been possible by some nations accepting less than their full requirements. The Lucerne plan gave the United Kingdom one long and ten medium wave-lengths; but in order to carry on its services, the B.B.C. has taken into use another long and two additional medium wave-lengths, which had been allocated to other countries. The new Copenhagen plan gives the United Kingdom one long and thirteen medium wave-lengths, and in some cases increased power may be used. These are considered to be sufficient for the B.B.C. programmes to be carried on substantially as they are at present.

German Scientific Text-books

DR. JULIAN HUXLEY writes: "Students of biological evolution will, I think, be interested to hear something about the new book by Dr. Bernhard Rensch, 'Neure Probleme der Abstammungslehre', published by Ferdinand Enke Verlag, Stuttgart, 1947, which I have recently received and read. It appears to me to be a most valuable work, which treats of the method, and especially the course, of evolution, in a comprehensive way. Its most original feature is the number of tables it contains, giving quantitative expression to various rules of evolution. It is also interesting in that the author, though working in complete isolation during the War, has arrived at conclusions in general similar to those reached by American and British specialists in the subject during the same period.

"It may be also useful to set forth the methods by which this, and other German books, may now be obtained. Anyone wishing to purchase books published in Germany may do so by placing his order through any bookseller, who may then apply directly to the publisher in Germany. The transaction is administered through the Joint Export and Import Agency of Military Government and payment can be made in the currency of the country in which the original order is placed. The delay in obtaining the book may be a matter of some weeks, or, of course, considerably longer if the publisher has not previously obtained a licence for export from the Joint Export and Import Agency. However, many publishers who foresee a demand outside Germany for a particular book will have obtained the required licence soon after the appearance of the book in Germany."

Chemical Names, Formulæ and Ciphers

THE system of notation of organic chemical compounds described by Dr. G. M. Dyson has quickly been followed by a second, and those who missed the original lecture in Birmingham last October will now be able to study at leisure what Messrs. Gordon,

Kendall and Davison describe as a universal notation covering inorganic and organic chemistry and the chemistry of ions, free radicals and transition complexes ("Chemical Ciphering." Pp. 46. London: Royal Institute of Chemistry. 4*s*. net). The claims are thus even larger than those of Dr. Dyson, and a logical proof of the validity of the ciphering is appended, given the definition of a chemical species as a set of atoms individually stated, in which given pairs of these atoms are linked together by directed bonds and the net charge of the set, and of any discrete ions contained in it, are specified. The authors claim, moreover, that the system is expressed in the language of "basic chemistry", and in accord with modern trends in the theory of molecular structure. Whether the system can be mastered by a chemist in about an hour, as they also claim, is at least doubtful; and if they under-estimate the intellectual effort required to comprehend and apply their system, they have probably also under-estimated the willingness of chemists as a body to make such an effort.

That factor has to be weighed against whatever advantages a cipher notation can offer. The crucial question is the reality of those advantages. Is there, for example, any real hope that mechanical methods, such as punched cards, will be sufficiently widely used to justify the considerable financial investment involved. If universal use is probable, what are the real advantages of an entirely new cipher notation over some extension of the Richter – Stelzner formula system, for such purposes? So far as systematics are concerned, what in economic terms are the advantages gained by a new system over the thoroughgoing application, for example, of the International Rules? A large part of the confusion and ambiguity in organic chemical nomenclature is due to the failure to apply those rules systematically and universally, and the very conservatism which has prevented such a relatively simple reform does not encourage optimism about the universal acceptance of systems involving so much larger an intellectual effort as well as a break with past practice.

Nigerian Livestock Mission

THE Secretary of State has sent a mission to visit West Africa to investigate the livestock industry in Nigeria and the Cameroons under British mandate, with particular reference to meat production. The Mission will also engage in discussion where necessary with the authorities of the neighbouring French territories on problems of mutual interest. The leader of the mission will be Sir Frank Ware, formerly animal husbandry commissioner to the Government of India, and the members will be Mr. Thomas Shaw, a director of Messrs. Zwanenberg-Organon, Ltd., and Mr. Gilbert Colville, who has special experience in the breeding-up of African cattle. Arrangements are being made for local officers of the veterinary, agricultural and geological departments to be attached to the mission. The mission will probably pay a further visit to West Africa in February or March to see the country and the cattle at the end of the dry season. During its first visit, the mission is spending a few days in the Gold Coast to discuss problems in connexion with the cattle industry there.

Irrationality of the General Cubic Threefold

REFERENCE has already been made in these columns (*Nature*, March 31, 1945, p. 385) to the proof by Prof. G. Fano, formerly of Turin, of a long-conjectured and important result in algebraic geometry. It has been known for nearly a century that the plane curve with equation $f_3(x, y) = 0$, where f_3 denotes a cubic polynomial, is in general irrational, that is, its points cannot be set in one-to-one algebraic correspondence with the points of a line; in fact, its co-ordinates are expressible as elliptic functions of a single parameter. In contrast to this the general cubic surface, given by an equation $f_3(x, y, z) = 0$, is rational, and the method of representing the surface biunivocally on a plane was obtained so long ago as 1866. It was thus natural to inquire whether the general cubic threefold, given by an equation $f_3(x, y, z, t) = 0$, is rational or not; the question posed by the Italian geometers some sixty years back long resisted all attempts at solution, and hence became one of the celebrated problems of geometry. In 1942, Fano (then in his seventieth year) at last established its irrationality; from Switzerland, where he was living as an exile, he communicated the discovery to the Pontifical Academy of Sciences, and this, after various delays, has now been published with cognate researches ("Commentationes", **11**, 635; 1947). Fano's proof, though conceptually simple, involves considerable detail, and, in fact, marks the conclusion to a long chain of investigations, dating from 1907, when Fano showed that the general quartic threefold $f_4(x, y, z, t) = 0$ is irrational. It is interesting to note that the entire programme of the research was foreshadowed in a communication made to the International Mathematical Congress held at Bologna in 1928; this has now been carried out in all its details.

The Little Ringed Plover in London

IN 1947 little ringed plovers (*Charadrius dubius curonicus*) bred in the London area for the fourth year in succession, and there was a remarkable increase in numbers (*British Birds*, **41**, No. 2; February, 1948). Eight nests were found, and four other broods seen. Because of the possibility that at least two pairs changed their sites after disturbance the exact number present is unknown; but there were certainly eleven and possibly fourteen pairs. Although the majority of the birds were again in Middlesex, there was an extension of range to three other counties and first breeding records were obtained for Essex (four pairs), Kent and Berkshire (one pair each). It is probable that the apparent sudden increase from four pairs in 1946 to a minimum of eleven pairs in 1947 is in part due to a lack of observation in previous years. It is curious that the known breeding range in Britain is, so far, restricted to Tring (where it bred in 1938 and 1944) and the London area (where it has bred annually since 1944). This may simply be due to lack of observation in other suitable places.

Turkish Technical Review

THE first issue (dated August 1948) has appeared of the *Turkish Technical Review* (*Teknik Dergi*), a monthly periodical which is claimed to be the first independent journal of that character published in Turkey apart from those coming from State institutions. It consists of forty-eight pages of text, with introductory notes by the Turkish Minister of Transport, by Prof. Tevfik Taylan, president of the Technical University of Istanbul, and the editors. There is an article on modern military tanks, another on jet motors and gas turbines, a description (translation) of a lathe with electronic control, an article (translation) on the application of plastics in chemical

apparatus and a section on textiles. In addition, there are the usual notes, abstracts of technical papers, reviews of books, notes on patents, etc., and the first page of a technical dictionary (English–Turkish–French–German). In each issue of the journal the contents page is to appear in the same four languages, and translations of any particular article will be prepared on request. The address of the new journal is: *Teknik Dergi*, Divanyolu Caddesi No. 16/3, Sultanahmet, Istanbul.

British Museum (Natural History)

THE galleries of fossil reptiles, fishes and plants in the Geological Department of the British Museum (Natural History) will be re-opened to the public on October 11. Most of the skeletons of the larger fossil animals had been dismantled and packed away in 1939, while others which could not be moved suffered damage during the War. The re-assembling and repair of all these specimens is still in progress; but the work is now sufficiently advanced to permit visitors to see once more the dinosaurs, the plesiosaurs and the ichthyosaurs. In the fossil fish gallery there is a series of dioramas of the fish-life of various geological periods from the Devonian onwards, and in Gallery VII there is a special exhibit illustrating the early history of palæontology. The rearrangement of the fossil plant gallery is not yet complete, but the student will find an adequate series of specimens exemplifying the plant life of the past.

Lighting Exhibition at the Science Museum

MANY of the exhibits in the "Darkness into Daylight" Exhibition at the Science Museum, London, which closed on October 6, were contributed by the Electric Lamp Manufacturers' Association; these have now been handed over to the Museum for incorporation in the permanent collection on illumination which is being re-modelled. The objects range from six dioramas illustrating the development of domestic lighting from medieval to modern times to a complete historical survey of the development of the fluorescent lamp. In addition, there is a working model illustrating stage lighting, many experimental and newly introduced types of lamp and several interesting demonstrations. The new illumination section of the Science Museum is being built in three sections. In the first, historical portion, the aim is to give a picture of the sequence in which lighting developed from prehistoric to modern times by a series of well-lit exhibits interspersed with a series of dioramas. The second section, most of which is in existence, illustrates by means of push-button demonstrations the principles upon which good illumination depends. The final section will be devoted to modern developments in discharge tubes and fluorescence. It is hoped to open the new section to the public early next year.

Navigation through the Ages

THE Institute of Navigation (c/o Royal Geographical Society, 1 Kensington Gore, London, S.W.7) is organizing, with the Royal Geographical Society, an exhibition of "Navigation through the Ages", to be held during December 17–January 20. The exhibition will be opened by the Duke of Edinburgh, and in connexion with it there will be three meetings of the Institute: "Radio and Position", by Sir Robert Watson-Watt (December 17); "The Navigator's Story", by Prof. E. G. R. Taylor and Prof. W. M. Smart (December 20); three films on radio systems, with a commentary by R. F. Hansford (January 10).

University of London: Appointments

THE following appointments in the University of London have been announced: Prof. L. Dudley Stamp, professor of geography at the London School of Economics and Political Science since 1945, to the University chair of social geography tenable at the School; Mr. J. V. Dacie, to the University readership in hæmatology tenable at the Postgraduate Medical School of London; Dr. C. L. Foster, to the University readership in biology tenable at St. Mary's Hospital Medical School.

Irish Chemical Association

AT the annual general meeting of the Irish Chemical Association, held in Dublin on September 22, the following officers and Council for the 1948–49 session were elected: *President*, Prof. T. S. Wheeler; *Vice-President*, D. Crowley; *Hon. Secretary*, G. F. O'Sullivan; *Hon. Treasurer*, J. G. Belton; *Council*, Dr. V. C. Barry, Dr. T. G. Brady, Prof. W. Cocker, Prof. T. Dillon, W. V. Griffiths, Miss M. MacNeill, N. V. Nowlan and F. T. Riley. Prof. Wheeler will deliver his presidential address, "The Training of a Chemist", in the Department of Chemistry, Trinity College, Dublin, at 7.45 p.m. on October 20.

Announcements

DR. RICHARD E. SHOPE, of the Rockefeller Institute for Medical Research, has been appointed associate director of the Merck Institute for Therapeutic Research. Dr. Shope is an authority in the field of experimental medicine and is known for his work on the virus of swine influenza. To provide Dr. Shope with special facilities for the study of animal pathology, a new building is being constructed in Rahway, N.J., by the Merck Institute.

DR. W. C. PRICE has been appointed to the University readership in experimental physics tenable at King's College, London, as from January 1, 1949. In 1937 Dr. Price became demonstrator in physical chemistry at the University of Cambridge, and during the War he worked at the Royal Aircraft Establishment, Farnborough, and for the Ministry of Supply and Ministry of Aircraft Production. Since 1943 he has been senior spectroscopist at the I.C.I. Physical Chemistry Research Laboratory, during which time he spent a session at the University of Chicago as research associate.

THE third commemoration day lecture at the Imperial College of Science and Technology will be delivered by Prof. Herbert Dingle on October 25. The title of Prof. Dingle's lecture will be "Some Reflexions on the History of Science".

MR. LEONARD CUNDALL, senior geography master at the Henry Thornton School, London, has been appointed a lecturer in the Department of Education of the International Wool Secretariat. He will lecture on wool to schools and adult educational bodies in the north of England and Scotland. Mr. Cundall, who graduated at the University of Leeds, has been chairman of the Secondary Schools' Standing Committee of the Geographical Association and of the Committee of the Assistant Masters' Association, which produced the "Memorandum on the Teaching of Geography" including the development of the wool industry in the West Riding.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Two New British Minerals

A WHITE mineral coating joint-faces in quarries in the Northampton Ironstone (Inferior Oolite) was long ago recorded as allophane. During the six-inch geological survey of that ironstone field during 1939–44 comparable material was widely recognized, and this note is published with the concurrence of the Director of the Geological Survey and Museum.

Exceptional developments were observed at the Lodge Pit of the Irchester Ironstone Co., two miles south of Wellingborough. Here the white material is present in its usual form as a wall coating associated with limonite and gypsum; but there are also widened joints or fissures up to one foot across occupied by white mineral enclosing fragments of oxidized ironstone. The white matrix of this fissure breccia includes compact, white mineral with a conchoidal fracture and a white plastic clay-like mineral.

Preliminary optical examination by Dr. J. Phemister had suggested the presence of more than one mineral, and it was noteworthy that the plastic material rapidly loses water in air and crumbles to a white powder which on wetting does not regain its plastic character. The air-dried material is fine-grained, anisotropic, with a mean refractive index close to 1·510.

X-ray examination reveals two predominant powder patterns, one corresponding to the fully hydrated mineral with longest spacing 12·9 A.; and a second pattern, easily distinguished from the first, with a longest spacing of 9·2 A. The pattern of the fully hydrated mineral was obtained free from that of the air-dried mineral by X-ray examination of a wet sample which had been kept in contact with water and sealed in a lithium-glass capillary. A few specimens yielded the X-ray halo pattern characteristic of allophane (hydrated aluminium silicate), and halloysite was also identified.

The silica percentages recorded by Mr. C. O. Harvey in the following partial analyses, made in the Geological Survey Chemical Laboratory, of two air-dried samples (Nos. 1 and 2) probably correspond to admixture of up to 5 per cent of allophane.

Chemical analyses of the new basic aluminium sulphate, basaluminite

	1	2	Composition for calc. $2Al_2O_3.SO_3.10H_2O$
	%	%	%
SiO_2	2·4	3·6	—
SO_3	15·6	14·2	17·2
Al_2O_3	43·0	41·3	44·0
Fe_2O_3	0·3	0·2	—
P_2O_5	tr.	1·0	—
Water (by difference)	38·7	39·7	38·8

The composition of the air-dried material is close to that of the mineral felsobanyite; but powder photographs of specimens of the latter in the British Museum collections are quite different from those of the Irchester minerals. It is suggested that the air-dried mineral should be called basaluminite to distinguish it from aluminite $Al_2O_3.SO_3.9H_2O$. The water content of the fully hydrated mineral with the longest spacing 12·9 A., for which the name hydro-basaluminite is suggested, is still unknown. Specimens maintained under conditions of constant temperature and humidity approach constant weight very slowly. Hydro-basaluminite loses approximately 50 per cent by weight at 16° C. in ten days, before it reaches constant weight and yields only the powder pattern of basaluminite.

As the plastic mineral can only be preserved indefinitely in the presence of water, it may well be that if suitable precautions are taken in the collection and preservation of other clays and clay-like substances other hydro-varieties of known minerals may be discovered.

F. A. BANNISTER

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British Museum (Natural History),
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S. E. HOLLINGWORTH

Geology Department,
University College,
London, W.C.1.

July 12.

Structure of Co_2Al_9

IN an earlier note[1] the determination of the unit cell and space-group of the phase which exists in equilibrium with the restricted solid solution of cobalt in aluminium was described. The ideal composition was shown to be represented by the formula Co_2Al_9. The space-group is P_{2_1}/a, and recent work has given more accurate values of the parameters, as follows: $a = 8{\cdot}5565 \pm 0{\cdot}0005$ A., $b = 6{\cdot}290 \pm 0{\cdot}005$ A., $c = 6{\cdot}2130 \pm 0{\cdot}0005$ A., $\beta = 94{\cdot}760° \pm 0{\cdot}005°$.*

From X-ray data obtained with molybdenum $K\alpha$ radiation it has proved possible to determine the structure by Fourier methods. Patterson projections on (010) and (001) together with a Patterson–Harker three-dimensional section at $(x\frac{1}{2}z)$ gave an indication of the positions of all twenty-two atoms in the unit cell. These positions were then confirmed, and the parameters refined, by two-dimensional Fourier synthesis. Final values of the parameters are:

Atom	x	y	z	
Co	0·333	0·615	0·265	± 0·001
Al_0	0	0	0	
Al_1	0·268	0·962	0·405	
Al_2	0·231	0·290	0·089	
Al_3	0·999	0·193	0·389	
Al_4	0·042	0·615	0·216	

The structure can be described as consisting of layers of aluminium atoms lying approximately in the planes $(0yz)$, $(\frac{1}{4}yz)$, etc., with cobalt atoms lying between the planes, slightly nearer to the planes at $x = \frac{1}{4}, \frac{3}{4}$. This layer structure is related to the habit of the crystals, which grow as plates parallel to the (100) plane. Each Co has a regular array of nine nearest neighbours—four in the plane $(\frac{1}{4}yz)$, four in the plane $(\frac{1}{4}yz)$ and one in the plane $(0yz)$, say; and these polyhedra of Al atoms are arranged with shared edges and corners in the (0 and $\frac{1}{4}yz$) planes, and shared edges in the $(\frac{1}{4}, \frac{1}{4}yz)$ planes. Observed values of interatomic distances lie for Co-Al within the range 2·38–2·52 A., and for Al-Al within the range 2·70–3·00 A.; the former are low compared with Pauling's predicted values[2], while the latter agree reasonably well.

An estimate of the number of electrons contained within the Co peak in the $(h0l)$ and $(hk0)$ Fourier syntheses, based on the assumption that the

* Note that here the x and z axes have been interchanged, compared with those given in ref. (1).

electron density between atoms is zero, indicates that the cobalt atom has of the order of two electrons more than its normal number of 27. This is in agreement with Raynor's theory[3] that in the alloys of transitional metals with aluminium, the transitional metals act as electron acceptors by filling up their atomic orbitals[4]. Also the radius of a Fermi sphere, corresponding to a number of electrons per unit volume calculated on the basis of Raynor's theory of electron acceptance by cobalt, is 1·948 A., which agrees well with the spacings of 1·959 A. and 1·939 A. of the strongest two lines on the powder photograph of Co_2Al_9.

The structure will be described in detail elsewhere.

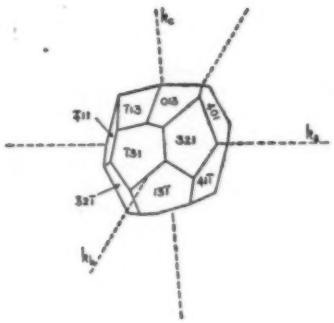
A. M. B. Douglas

Crystallographic Laboratory,
Cavendish Laboratory,
Free School Lane,
Cambridge.
July 6.

[1] Parker, A. M. B., *Nature*, **156**, 783 (1945).
[2] Pauling, L., *J. Amer. Chem. Soc.*, **69**, 542 (1947).
[3] Raynor, G. V., *Phil. Mag.*, **38**, 770 (1945).
[4] Pauling, L., *Phys. Rev.*, (11), **54**, 899 (1938).

It is most gratifying to note the agreement of the results of Mrs. Douglas' determination of the crystal structure of Co_2Al_9 with the theory that, in aluminium-rich alloys, transitional metal atoms absorb electrons by filling up their atomic orbitals[1]. This work emphasizes the importance of crystallographic studies in the development of alloy theory.

Mrs. Douglas shows, in her letter, that the radius of the Fermi sphere, calculated according to the theory of electron acceptance, is in agreement with the spacings of the strongest two lines in the diffraction pattern. Since Mrs. Douglas very kindly informed us of her crystal structure results prior to publication, it was possible to make an independent examination of the Brillouin zone structure of the compound, which confirms her findings.



The strongest two lines in the diffraction pattern appear to result from the overlapping of reflexions from the $(\bar{4}11)$, (321), (401), (013), $(\bar{1}13)$ and $(\bar{1}31)$ planes. In k-space these planes define a closed volume of the form shown in the accompanying diagram. The perpendicular distances of these planes from the origin of k-space lie between the closely similar values of 0·2543 recip. A. (for planes of the type $\bar{4}11$ and 410) and 0·2570 recip. A. (for planes of the type $\bar{1}31$ and $\bar{1}13$). Fermi spheres having these radii correspond respectively to 2·1 and 2·15 electrons per atom; the 'average' Fermi sphere, with radius equal to the mean perpendicular distance of all six planes from the origin, corresponds with 2·12 electrons per atom. The bounding planes of the Brillouin zone are therefore touched by the Fermi sphere when 2·12 electrons per atom are present. This is in very close agreement with the value of 2·125 electrons per atom, characteristic of the experimentally determined composition of Co_2Al_9 crystals extracted from aluminium-rich aluminium–cobalt alloys[2], the number of electrons per atom absorbed by cobalt[1] being taken as 1·71. These results add further support to the view that compounds of this type are properly to be regarded as 'electron compounds'[3].

G. V. Raynor
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Department of Metallurgy,
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Edgbaston,
Birmingham 15.
Aug. 1.

[1] Raynor, G. V., *Phil. Mag.*, **38**, 770 (1945).
[2] Raynor, G. V., and Pfeil, P. C. L., *J. Inst. Metals*, **73**, 609 (1946–47).
[3] Raynor, G. V., and Waldron, M. B., *Proc. Roy. Soc.* (In the press

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Decay of Barium-139

The isotope Ba^{139} is radioactive with a half-life of 85 min. decaying to La^{139} by β^- emission. This activity was first reported by Pool and Cork[1]. Kalbfell and Cooley[2], using absorption methods, have reported a continuous β-spectrum with a maximum energy of 1 MeV. accompanied by γ-radiation of energy 0·6 MeV., while Born and Seelmann-Eggebert[3] report a maximum β-energy of 2·3 MeV. also by an absorption method.

In the present experiments investigation of the activities was made by means of a thin-lens β-ray spectrometer and by absorption and coincidence techniques.

Ba^{139} was produced by bombarding fused barium nitrate with 7 MeV. deutrons in a cyclotron. After bombardment the barium was separated from lanthanum and sodium and precipitated in the form of amorphous carbonate. (Lanthanum activity is produced by Ba-dn-La reaction and Na^{24} by Al^{27}-$n\alpha$-Na^{24} reaction with the aluminium target plate.) After this separation the β- and γ-radiation both decayed with a period of 84 ± 1 min. and no contamination could be detected over five half-life-times.

Fig. 1 shows the momentum distribution of the β-spectrum obtained in the β-ray spectrometer. This

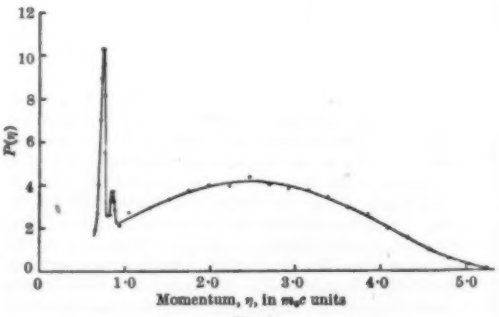

Fig. 1

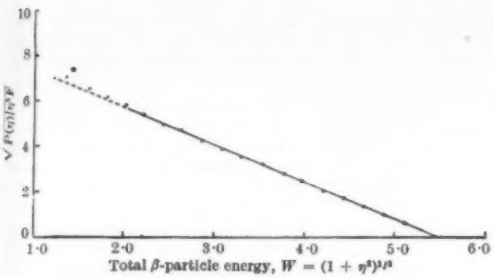

Fig. 2

spectrum was obtained using a source of thickness 3 mgm. cm.$^{-2}$ and about 1 sq. cm. in area deposited on thin aluminium foil. The spectrometer resolving power was about 15. A Fermi plot of this spectrum is shown in Fig. 2. This indicates a maximum kinetic energy of 2·27 ± 0·02 MeV. In addition to the continuous β-spectrum two conversion electron groups were found having energies of 126 ± 0·5 keV. and 159 ± 2 keV. These groups correspond to the *K* and *L* electrons from the conversion of a γ-ray of 163 ± 0·5 keV. in the product nucleus. From Fig. 1 it is estimated that the ratio of conversion electrons to β-particles is 5 ± 1 per cent and the ratio $N_K/N_L \sim 6$.

Fig. 3 shows the absorption curve obtained using lead absorbers and a brass γ-counter, the β-particles being absorbed in polythene. The majority of the radiation has a mass absorption coefficient of 1·38 cm.^{2} gm.$^{-1}$ corresponding to the 163 keV. γ-ray. About 10 per cent of the counting rate appears to be due to a harder γ-ray of energy 1·05 ± 0·1 MeV. By the use of calibrated β- and γ-counters the intensity of the γ-radiation was estimated. Expressing these intensities as a percentage of the total number of disintegrations, the number of quanta escaping is estimated as 26 ± 3 per cent for the 163 keV. γ-ray and ~ 0·6 per cent for the 1 MeV. γ-ray. An attempt was made to confirm the energy of this harder γ-ray by means of Compton recoil electrons in the β-ray spectrometer; but the relatively low intensity available together with the short life-time prevented any useful results being obtained by this method.

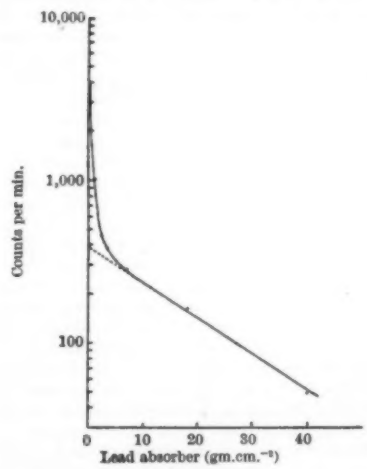

Fig. 3

Coincidences were obtained between β-particles and γ-rays and between β-particles and conversion electrons. From the latter the percentage of conversion electrons was estimated and the result was in good agreement with that obtained by the spectrometer. The product nucleus is La^{139}, which has a spin of 7/2 in the ground-state, and it was thought that the 163 keV. level might have a measurable metastable life-time. No such life-time could be detected with our equipment, which had a lower limit of 10^{-7} sec.

L. R. Shepherd
J. M. Hill

Cavendish Laboratory,
Cambridge.
July 17.

[1] Pool, M. L., and Cork, J. M., *Phys. Rev.*, **51**, 1010 (1937).
[2] Kalbfell, D. C., and Cooley, R. A., *Phys. Rev.*, **58**, 91 (1940).
[3] Born, H. T., and Seelmann-Eggebert, W., *Naturwiss.*, **31**, 210 (1943).

Preparation of Pure Iron-59 of High Specific Activity

The preparation of Fe^{59} by (slow n,γ) reaction on potassium ferrocyanide has been described by Dewhurst and Miller[1]. The reaction is of the Szilard–Chalmers type, so that the active iron could be obtained by precipitation on aluminium hydroxide at specified *p*H; three precipitations were necessary to obtain 'a clean 47-day activity'.

We have irradiated hydroferrocyanic acid in the Harwell low-energy pile (G.L.E.E.P.), this compound being chosen to avoid formation of the short-lived K^{42} which emits very penetrating β- and γ-radiation and which is produced in far greater amount than is the Fe^{59}, when potassium ferrocyanide is irradiated. From the irradiated hydroferrocyanic acid, which is blue, Fe^{59} may be obtained very simply by extraction with dry, dilute ethereal hydrochloric acid in a Soxhlet apparatus.

After irradiation for a month (slow neutron flux $2·5 \times 10^{10}$/sq. cm./sec.), the activity of the solid was determined before and after extraction with a Geiger–Müller tube having a window thickness of 4 mgm./sq. cm. It was found that 50 per cent of the total activity remained. The activity of the hydroferrocyanic acid was too low (70 counts/min./mgm.) to permit an absorption curve, owing to self-absorption, so that it is not possible to state how much of the total activity is Fe^{59}. The other 50 per cent of the total activity was accounted for in the ethereal extract, so that no loss of activity, say as gaseous products, occurred.

Most of the activity which could be extracted was extracted in the first hour; after two and a half hours no further extraction occurred. The blue colour partially faded during extraction.

The ethereal extract was taken just to dryness and the greenish-black residue digested with water for two hours

(*a*) The aqueous extract contained at least 90 per cent of the activity extracted by the ether and was proved to be radioactively pure Fe^{59} by its absorption curve[2].

(*b*) The residue was partially soluble in alcohol. Removal of the alcohol from the extract left a black oily material which carried the remaining 10 per cent of the extracted activity. An absorption curve showed this to be almost pure C^{14}.

(*c*) The residue from the successive aqueous and alcoholic extractions was greenish-black and carried very little, if any, activity.

The amount of iron extracted during this process is small, about 300 μgm. per gm. of hydroferrocyanic acid, as determined spectroscopically. Parallel experiments showed that this iron is not produced by irradiation, but is extracted also from unirradiated hydroferrocyanic acid. The specific activity of the Fe^{59} is therefore about 1·5 mc./gm. It is hoped to repeat and extend these experiments, and also to obtain higher specific activity, with samples irradiated in the bigger pile now in operation at Harwell.

A. W. KENNY
W. R. E. MATON

Ministry of Supply,
Atomic Energy Research Establishment,
Harwell, Didcot.
July 30.

[1] Nat. Res. Coun. Canada Report, C.R.C. 351.
[2] Cf. Livingood and Seaborg, *Phys. Rev.*, **54**, 51 (1938). Deutsch, Downing, Elliott, Irvine and Roberts, *ibid.*, **62**, 3 (1942).

Distribution of Ice-Particle Nuclei in the Free Atmosphere

CWILONG[1] has determined the highest temperatures at which ice forms in the cloud produced by adiabatic expansion in a Wilson cloud chamber. He found a threshold temperature of $-41{\cdot}2 \pm 0{\cdot}2°$ C. for air which had been cleaned by repeated expansions, and of $-32 \pm 1{\cdot}0°$ C. for outdoor air at Oxford. He has since repeated the experiments with outdoor air on the Jungfraujoch[2], and on the Atlantic and Pacific Oceans[3]: he found the clean air threshold on all but one occasion.

During the past year an apparatus similar to that used by Cwilong has been fitted to a Halifax aircraft of the Meteorological Research Flight at Farnborough, and measurements have been made in flight on four occasions. On each flight the threshold temperature for the free air was determined at two or three levels. On two of the flights there were pronounced anticyclonic inversions at about 5,000 ft., while on the other two the *radio-sonde* ascents showed no marked inversions, though stratus cloud or a haze-top showed that the air was stratified.

The clean air threshold was found in all measurements above the inversions, the stratus, or the lowest haze-top, while the measurements below these levels gave $-33°$ C. to $-35°$ C. On one occasion two haze-tops were observed, and the clean air threshold was found above the lower. The greatest height at which the threshold has been observed to be above $-41°$ C. is 8,000 ft., while the lowest at which the clean air threshold has been found is 6,000 ft. These results were obtained in winter and early spring, and they suggest that the nuclei active at $-32°$ C. are only present in air which has recently been in contact with the surface.

The greatest height reached was 18,000 ft., and there the threshold was measured as $-44°$ C. Clean air from a compressed air cylinder was also examined at this height, and gave $-44°$ C. It is not certain whether this is a true variation of the threshold or an instrumental effect. The expansion ratios were controlled to give final temperatures accurate to $\pm 0{\cdot}5°$ C., and the apparatus will detect nuclei present in concentrations of 10/litre.

I am indebted to the Director of the Meteorological Office for permission to make the flights, and publish the results, and to Dr. Frith of the Research Flight for his unfailing helpfulness in the air and on the ground. Prof. G. M. B. Dobson suggested this research, and it is a pleasure to acknowledge his continued interest and many valued suggestions.

H. P. PALMER

Clarendon Laboratory,
Oxford.
July 3.

[1] Cwilong, B. M., *Proc. Roy. Soc.*, **190**, 137 (1947).
[2] Cwilong, B. M., *Nature*, **160**, 198 (1947).
[3] Cwilong, B. M., *Nature*, **161**, 62 (1948).

Frictional Electrification of Sand

A VERY simple experiment seems to have a meteorological significance.

A small plate about one square inch in area was attached to the insulated quadrant of a Dolezalek electrometer. A cupful of fairly dry sand was then poured through a funnel and allowed to fall some three feet to the floor. The electrometer plate was three yards away from the dropping sand. The passage of the sand through the funnel took about half a minute, and while it was dropping there was no effect on the electrometer; but soon after, the electrometer began to show a deflexion which continued to increase for three or four minutes. This deflexion corresponded to the plate receiving positive charge. Having reached a maximum deflexion of a volt or so, the deflexion commenced to decrease, and continued to do so for a few more minutes and finally came to rest near its original zero position. In this stage the plate must have been receiving negative charge. That this decrease was not due to faulty insulation was checked by another experiment in which the plate was momentarily earthed when the deflexion reached its maximum, and it then charged up negatively in the last few minutes.

As the whole phenomenon occurs after the sand has ceased to drop, any explanation based on induction must be ruled out and the plate must have received positive charge through the air in the first few minutes, and an approximately equal amount of negative charge in the last few minutes. What is the source of these charges and why do the positive arrive first? The sand in its passage through the funnel gets charged negatively by friction, as is easy to show by letting a little of it fall into a metal cup connected to the insulated quadrant of the electrometer, and the question is therefore where does the positive charge come from? It was thought at first that the falling sand might, by friction, electrify the air, producing positive and negative ions which diffuse at different rates. There are several reasons against this, and the main one is that the kinetic energy of the ions would only be sufficient to charge up the plate to a very small fraction of a volt. The particles must, therefore, be very much larger, and one is driven to the conclusion that they are dust particles of the sand itself. Furthermore, they must be a mixture of small particles with a positive charge and larger particles with a negative, because the carriers of the positive diffuse, or are carried by convection, quicker than the carriers of the negative.

The frictional effect of the funnel always charges the sand negatively whatever the size of the particles, so the final conclusion reached is that the sand rubbing on itself must produce positive charges on the smallest particles and negative charges on the larger.

The electrometer had an approximate capacity of 50 E.S.U., and considering the smallness of the

collector plate and its large distance from the dropping sand the total amount of charge produced by the sand is surprisingly large. The meteorological application is, of course, obvious. When sand is blown about on a big scale, very large charges must be produced, and the different rates of diffusion or convection separate the charges. The comparative largeness of the particles means that the motion is little interfered with by the electrostatic forces due to the charges on the various particles, so that the diffusion or convection will result in very large potential differences being set up.

Many years ago, on the Salonika front, I noticed that when a dust storm was approaching my wireless station the aerials started sparking violently when the dust cloud was some way off; sparking then ceased for a while, to recommence with equal violence when the storm hit the camp. This has an uncommon resemblance to the electrometer experiment, the first sparking being due to particles too fine to be visible.

E. W. B. Gill

Electrical and Clarendon Laboratory,
Oxford.
July 16.

Influence of Reactive Feedback Networks on the Response of Galvanometers

In the course of an investigation into servo circuits and self-balancing systems in general I had opportunity to examine the effect of reactive elements in the negative feedback networks of electronic amplifiers on the response characteristics of current measuring instruments. Detailed mathematical analysis revealed a number of facts which make it appear probable that a reactive feedback circuit can be used as an alternative to other negative feedback circuits in galvanometers, such as the twin-coil meter[1] or the mirror-and-photocell instrument[2,3,4], without interference with the mechanism of the instrument itself.

If a voltage v is applied to an electronic amplifier of gain A in the output of which is connected a network consisting of the resistances R_1 and R_2, the condenser C and the inductance L, and if also the voltage appearing on the junction between L and C is fed back in series with and negatively to the input voltage, then the frequency response of the amplifier is made to depend on the characteristics of the feedback circuit (Fig. 1). If the output is connected to a current instrument, via a buffer stage, the response of the pointer will depend both on the voltage-time function of the input and the characteristics of the feedback circuit. In this case, the differential equation governing the deflexion-time function is an inhomogeneous one of the fourth order, the forcing function being the input voltage v. If, however, the damping and frequency of the feedback circuit and those of the meter are made equal, for example, by suitable choice of values of the circuit constants, the equation reduces to one of the second order. This equation is similar to the one governing the meter deflexion itself (that is, in the absence of the feedback network), except that the coefficient of the zero order term now contains an additional term proportional to A. The effect of this feature is that while the damping remains unaltered, the natural frequency calculated from the equation can be increased freely by the simple expedient of suitably adjusting the gain of the amplifier. The mathematical treatment bears considerable resemblance to the resonant shunt method of influencing the response of galvanometers, which is, indeed, a special case of the present device[5,6,7].

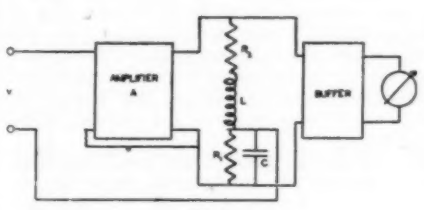

Fig. 1

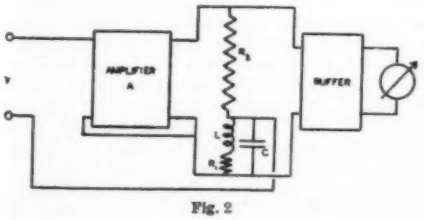

Fig. 2

The result is formally identical with the conditions obtaining in any of the other electrical or electro-optical feedback galvanometers quoted in the references; in the present case, however, there is no need for any additional mechanical attachments to the instrument or any modifications of its internal design. If the instrument is originally overdamped, it can be brought back to 'dead beat' conditions by a simple gain control operation. A preliminary experiment to check the theory was carried out with an Evershed and Vignoles recording milliammeter, the dashpot of which was filled with glycerine. A directly coupled amplifier was adjusted until dead beat conditions were re-established. In this way it was possible to make the response of the meter extremely fast, the response time being of the order of 1/10 sec.

Another possibility of using reactive feedback networks to influence the response of a meter lies in placing the inductance L into the other arm of the network (Fig. 2). Here the conditions are exactly analogous. The galvanometer equation, adapted to include the special feature of the feedback circuit, is again of the fourth order, reducing to one of the second order, if the feedback network is 'tuned' in frequency as well as damping to the galvanometer. But now the coefficients of both the zero and first-order term contain an expression proportional to A. Thus the apparent damping as well as the apparent frequency is affected, the latter being reduced as A is increased. This circuit is therefore particularly useful in conjunction with underdamped instruments. It returns them to conditions of critical damping or, if desired, to over-critical behaviour.

It is probable that similar circuits to the ones discussed can be used for affecting the characteristics of a meter in any desired way, by suitably combining reactive and resistive components or by a sequence of circuits of the types mentioned, one feeding into the next and finally into the meter. The possibility

of a general mathematical approach is being investigated.

A detailed paper is to be published shortly.

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June 3.

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Biological Properties of a Substance Isolated from Wheat Middlings and of Hydroxymethylfurfuraldehyde

Following on the description many years ago[1] of a growth-inhibiting constituent of yeast, a number of plant extractives[2] and pure substances[3] have been reported to possess similar activity. A distinctive feature in the case of most of them is that in cultures *in vitro* the growth of connective tissue cells is inhibited, but not that of epithelia. From this the conclusion was drawn that such action, if exerted *in vivo*, would lead to the retardation of growth in young animals since this depends upon the growth of their connective tissue, without interference with the vitality of such other tissues as the skin and blood-forming organs, the cells of which continue to multiply throughout normal life. A further inference was made that the growth of tumours might similarly be inhibited, since this too depends upon a parallel growth of stroma. These expectations were, in fact, to some extent realized[4], but owing to the unsatisfactory nature of the material used the experiments were unconvincing.

It now appears that action of this kind is not specific, being shown in varying degree by a number of aldehydes[5,6], lactones[3,7] and other substances[8] containing unsaturated groups.

In the course of further attempts to isolate the naturally occurring agent from plant sources a substance has been prepared from wheat middlings which is clearly of carbohydrate nature but has not yet been completely identified. In very brief outline the process is the following. Wheat middlings are quickly extracted with 80 per cent alcohol (½ hr. stirring; all processes must be expeditiously conducted), the extract concentrated under diminished pressure below 60° to a small volume, washed with benzene, concentrated below 60° nearly to dryness, washed again with benzene, and excess absolute alcohol then added. The sticky solid precipitated is then twice extracted with hot absolute alcohol and the insoluble residue triturated with cold 95 per cent alcohol. The substance is then taken up in hot 95 per cent alcohol and the solution is evaporated under low pressure. A modification of this procedure has been employed in later experiments but the statements in the text apply to material made as described. Tested on young rats, it has been found to arrest growth at a daily dose of about 1 mgm., given by the mouth. The effect is immediate and ceases directly administration is discontinued.

During the progress of the work the probability seemed to emerge that a characteristic structural feature was a furanose group, for the product was convertible by acid to hydroxymethylfurfuraldehyde. This substance had already been found effective in arresting the growth of rats, at a dose of about 2 mgm. per day, and similar activity was shown by the relatively insoluble polymer which tends to form spontaneously when hydroxymethylfurfuraldehyde, prepared in the pure state from cane sugar, is kept.

When tested on rats bearing the Walker carcinoma, all these three substances have been found to cause retrogression of the tumours, taking effect in about a week. The dose necessary for the purpose is considerably larger, namely, about 15–45 mgm. per rat per day in the case of hydroxymethylfurfuraldehyde; in all three cases it was noted that at this high level of dosage the increase of body-weight is no longer arrested but, if anything, accelerated.

In a future communication more details will be given and, it is hoped, an indication of the precise nature of the active substance which we have isolated from wheat middlings, or, in some experiments, from malt extract. The two are not necessarily identical though they appear to have similar properties.

We wish to express our obligation and thanks to Sir Robert Robinson for stimulating help and advice.

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Assay of *nor*Adrenalin and Adrenalin in Extracts of Nerves and Tissues

Recent investigations have shown that the sympathomimetic activity present in several organs and in large amounts in adrenergic nerves, for example, the splenic nerves of cattle, is chiefly due to lævo-*nor*adrenalin or *l*-arterenol, which has been identified by quantitative biological and colorimetric tests (Euler[1,2]). By using the cat's blood pressure in conjunction with the fowl's rectal cæcum (Barsoum and Gaddum[3]) as test preparations, showing activity ratios for *l*-adrenalin and *l*-*nor*adrenalin of 1 : 2–4 and 20–30 : 1 respectively, adrenalin has been detected in extracts of spleen, and splenic nerves, in amounts corresponding to 1–4 per cent of that of *nor*adrenalin.

The biological assays have been facilitated by using a method of purification, depending on adsorption of the sympathomimetic activity on aluminium hydroxide (Shaw[4]). In order to increase the amount recovered with this method, the aluminium hydroxide, instead of being added as such, was formed in the trichloracetic acid extract of the organs by adding aluminium sulphate and sodium hydroxide. Adsorption was carried out at *p*H 7, and was practically complete even with small amounts of aluminium hydroxide. The washed precipitate was dissolved in sulphuric acid, and the aluminium sulphate removed by precipitation with four volumes of ethanol at *p*H 3·5. About 70 per cent of the sympathomimetic activity was recovered by this procedure, and, since the extracts were only slightly coloured, and showed

almost no contamination with other substances likely to interfere with the tests, it could be used directly for biological and colorimetric assays. The relative proportions of adrenalin and *nor*adrenalin were the same as in the crude extracts. For spleen and splenic nerves from cattle, the following ranges of figures may be regarded as representative.

Tissues (cattle)	*l*-adrenalin-HCl	*l*-arterenol-HCl	
Splenic nerves	0·2 – 0·5	10–20	μgm./gm.
Spleen	0·05–0·12	2–4	,,

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Alloxan Diabetes in Dogs with Renal Pedicles Clamped

Jiménez Díaz, Grande Covián and De Oya[1] have reported that in dogs in which the vessels of both kidneys were clamped, the intravenous injection of alloxan in doses of 80–100 mgm./kgm. failed to produce either the hyperglycæmia or uræmia observed in controls in which the clamping was omitted. They postulated that "contact between alloxan and the kidney is apparently necessary for the display of the full diabetogenic effect". However, diabetes was observed on injecting alloxan during clamping of both renal pedicles in rats[2,3] and rabbits[4]. Recently, Jiménez Díaz and Souto Candeira[5] postulated that "alloxan produces some kind of renal injury which accentuates diabetes. . . . In conclusion, the kidney is apparently not necessary for the production of alloxan diabetes, but renal injury produced by alloxan would contribute to accentuate it."

Experiments were performed on dogs anæsthetized with 'Nembutal' (33 mgm./kgm. intraperitoneally). Alloxan was injected intravenously (75 mgm./kgm.) in 25–45 sec. The fasting blood sugar-level was determined before and 24–48 hr. after the injection of alloxan. Some of the animals died before the end of 48 hr., so these have not been considered as valid. Out of fifteen controls thirteen developed diabetes after alloxan injection. The clamping of both renal pedicles followed by the alloxan injection had a clear protective effect since only two dogs out of eleven developed a full diabetic condition (see accompanying table).

Diabetes due to intravenous injection of alloxan (75 mgm./kgm.) in dogs anæsthetized with 'Nembutal' (33 mgm./kgm. intraperitoneally)

Procedure	Diabetic
Controls	13 out of 15
Renal pedicles clamped	2 ,, 11
Renal vessels clamped	3 ,, 8
Renal nerves clamped	2 ,, 9
Spleen vascular pedicle clamped	0 ,, 6
Renal denervation and clamping	1 ,, 7
Bilateral nephrectomy before alloxan	5 ,, 5
Bilateral nephrectomy 2–12 hr. after renal clamping and alloxan	7 ,, 11

When clamping was limited to the vessels (both renal arteries and veins), excluding nervous structures, only three out of eight dogs which were injected with alloxan developed diabetes. Likewise the clamping of both renal pedicles, excluding only the vessels, protected seven out of nine dogs so injected.

Alloxan injected immediately after denervation of both renal pedicles, leaving the renal arteries and veins intact (without clamping), also protected six out of seven dogs.

Alloxan injected after bilateral nephrectomy caused an intense diabetes in all of five dogs. The same result was observed in seven out of eleven dogs in which bilateral nephrectomy was performed 2–12 hr. after clamping and injecting alloxan.

Finally, after injecting the alloxan after clamping the vascular pedicle of the spleen and maintaining the vessels clamped for 15 min. after the injection, all of six dogs failed to develop diabetes.

These results confirm the observation that alloxan injection, immediately after clamping of both renal pedicles in the dog, fails to produce diabetes although microscopically lesions of variable degree in some β-cells of the islets have been found. The same protection has been produced: (*a*) by clamping either the renal vessels only or the nervous structures; (*b*) injecting the alloxan after denervation of both renal pedicles leaving intact the vessels; (*c*) injecting the alloxan after clamping the vascular pedicle of spleen.

Furthermore, the injection of alloxan after bilateral nephrectomy was followed by a full diabetic condition. Thus it seems that the presence of intact kidneys is not necessary in order to obtain diabetes after alloxan injection.

However, uræmia seems to increase the severity of alloxan diabetes, since when nephrectomy is performed 2–12 hr. after the alloxan injection in dogs with both renal pedicles clamped, diabetes developed in seven out of eleven dogs.

The results of these experiments suggest the possibility that some kind of vasomotor reflex in the pancreas can be elicited from the renal pedicles due to clamping, as was suggested by Gold[2]. In order to confirm this hypothesis, several experiments were carried out, injecting 3 c.c. of indian ink into the descending aorta, using a cardiac catheter introduced through the left carotid artery. The pancreas was removed 3 min. after the indian ink injection. The results were as follow: in four control dogs the pancreas showed a dark colour of variable intensity due to the indian ink injection; but in four dogs in which both renal pedicles were clamped immediately before the injection, the pancreas showed its normal colour or was just a little darker. Microscopical examination of the islets in the controls showed many capillary vessels with plenty of indian ink, while in the islet vessels of the clamped animals scarcely any indian ink was observed. These experiments seem to confirm the hypothesis suggested by Gold that a vaso-constrictor reflex in the pancreas can be elicited by the mechanical procedure of clamping, and thus prevents injected alloxan reaching the islets in sufficient concentration to produce destruction of β-cells and diabetes.

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Effect of Hypophysectomy on Glycogen Deposition in Isolated Muscle

RESULTS of experiments previously reported from this Institute in 1944 [1] indicated that when extracts of the anterior pituitary gland were administered to rats, insulin did not exhibit its usual action in promoting glycogen deposition in muscle as studied on the rat's diaphragm according to the technique of Gemmill[2]. In 1945 Cori *et al.*[3] reported the results of experiments on the effect of anterior pituitary extract and of insulin on hexokinase activity in tissue extracts obtained from rats.

It was found that when anterior pituitary extract was either injected into the intact animal or added to tissue extracts, hexokinase activity was inhibited. However, when insulin was added to such extracts, it appeared that this latter hormone released hexokinase from the anterior pituitary extract inhibition. Further, Cori considered that insulin *per se* did not enhance hexokinase activity.

As our investigations were carried out on intact muscle, it is difficult to make any strict comparison with the experiments of Cori.

It seemed, however, that any direct effect of insulin on hexokinase activity would be best investigated on hypophysectomized animals. Thus the inhibiting effect of the anterior pituitary on the hexokinase activity would be abolished, resulting in increase of glycogen deposition as compared with normal animals; and if a further increase occurred as a result of the addition of insulin it would be reasonable to assume that insulin exerted a direct action on hexokinase activity.

On the other hand, insulin should have no effect on the deposition of glycogen in the diaphragm of the hypophysectomized rats if its action were limited to the release of anterior pituitary inhibition.

In our experiments the methods employed have been reported in previous papers[1,4]. Hypophysectomy was performed according to the technique of Thompson[5].

Ten to fourteen days were allowed to elapse between the operation and excision of the diaphragm. A summary of the results obtained are shown in the following table.

Normal rats Mean of 28 animals			Hypophysectomized rats Mean of 20 animals		
Glycogen %			Glycogen %		
Without insulin (*a*)	With insulin (*b*)	Increase (*c*)	Without insulin (*d*)	With insulin (*e*)	Increase (*f*)
0·269	0·53	0·261	0·364	0·766	0·402

For columns (*a*) and (*d*) $t = 4{\cdot}19$ P 0·001
(*c*) and (*f*) $t = 5{\cdot}6$ P 0·001

From these results it appears that hypophysectomy increased the hexokinase activity in the isolated diaphragm of the rat and that it is further enhanced by the addition of insulin. Thus we are of the opinion that insulin has a direct effect on hexokinase activity.

We would like to express our sincerest thanks to Mr. A. F. Doutch for the statistical analysis.

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Cytochemical Demonstration of Ketosteroids

IN a number of cytochemical papers[1,2] it has been claimed that α-hydroxyketones, such as deoxycorticosterone, give a purple colour with reduced fuchsin in Feulgen's 'plasmal' reaction. In this reaction the material under test is treated with cold saturated aqueous mercuric chloride solution, then with reduced fuchsin. According to Dempsey *et al.*[3], aqueous mercuric chloride oxidizes the hydroxyketone to an aldehyde, which then reacts with reduced fuchsin.

We have now studied this reaction with three pure samples of deoxycorticosterone, one kindly supplied by Prof. T. Reichstein, Pharmazeutische Anstalt der Universitaet Basel, one kindly supplied by the British Drug Houses, Ltd., and the other prepared by one of us (C. W. S.) by hydrolysis of a sample of deoxycorticosterone acetate kindly supplied by Dr. F. T. Hewett, Organon Laboratories, Ltd., London, S.W.19. The sample prepared from the acetate was purified by sublimation at 0·001 mm. and recrystallized from ether.

With none of these samples have we been able to obtain any evidence of oxidation of deoxycorticosterone to an aldehyde by aqueous mercuric chloride.

We conclude that this technique cannot be relied upon to demonstrate the cytological location of α-hydroxyketones. Our experiments have been restricted to one such compound; but the facts of organic chemistry indicate that the α-hydroxyketo-grouping in deoxycorticosterone may be regarded as typical, and only atypical α-ketols, if any, will react as postulated by Dempsey and Wislocki.

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p-Aminobenzoic Acid a Growth-Factor for Certain Brewer's Yeasts

MOST of the single-cell strains of English brewery top fermentation yeasts so far examined grow well at 25° C. in forty-eight hours in a synthetic glucose-mineral salts medium, containing $(NH_4)_2HPO_4$ as the sole source of nitrogen and biotin, pantothenic acid and inositol as accessory growth factors ('bios').

However, two single-cell strains, isolated from different breweries, failed to grow even after six days incubation at 25° C. in the medium containing the three factors mentioned above and in addition riboflavin, aneurin, nicotinic acid and pyridoxin. The missing factor proved to be *p*-aminobenzoic acid, addition of 0·01 μgm. per ml. of which induced heavy growth in the presence of other essential bios factors. One strain, designated 'Yeast 45', required biotin as an essential growth factor in addition to *p*-aminobenzoic acid, pantothenic acid (or β-alanine) being strongly stimulatory, but not essential for good growth. The other strain ('Yeast 47') required both biotin and pantothenic acid (or β-alanine) in addition

to *p*-aminobenzoic acid as essential bios constituents, while inositol and a mixture of riboflavin, aneurin, nicotinic acid and pyridoxin each has a stimulatory effect.

While *p*-aminobenzoic acid is recognized as a growth factor for many organisms, of which *Acetobacter suboxydans*, *Clostridium acetobutylicum*, *Lactobacillus arabinosus* and *Neurospora crassa* have been employed for microbiological assays of *p*-aminobenzoic acid, I am not aware that strains of brewer's yeast exacting towards *p*-aminobenzoic acid have been reported. The response of 'Yeast 45' and of 'Yeast 47' to *p*-aminobenzoic acid is so striking as to suggest that either organism may prove suitable for the microbiological assay of the vitamin.

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A Test for Mutagenicity of Methylcholanthrene

RECENT results by Strong[1,2] and by Carr[3] on mice, and by Demerec[4] on *Drosophila*, have focused interest on a possible connexion between mutagenicity and carcinogenicity, which in the past has often been claimed on theoretical grounds. While Auerbach[5] failed to produce mutations by injection of 1 : 2 : 5 : 6 dibenzanthracene into *Drosophila*, Demerec obtained positive results with a number of carcinogens, including dibenzanthracene and methylcholanthrene, when these were administered to the flies in the form of aerosols. Still a different possibility of administration is by addition of the carcinogen to the food of the larvæ, since fluorescence tests carried out by Fabian and Matoltsy[6] have shown that methylcholanthrene given in this way enters into the gonads. An experiment using this method was under way when Demerec's first results were published, and its outcome will be briefly presented. The food contained powdered methylcholanthrene in a concentration of 0·01 per cent. No live yeast was added to the culture vials, in order to avoid complications through offering the larvæ an alternative supply of untreated food. Fluorescence tests showed that methylcholanthrene or a fluorescent derivative of it had penetrated into the gonads of the imagines which emerged in the treated vials. In spite of this, no evidence for mutagenic action of methylcholanthrene was obtained in tests for sex-linked lethals. Only two lethals were found in 1,012 chromosomes from treated ♂♂ (compared with one in 1,007 control chromosomes), and three in 1,026 chromosomes from treated ♀♀ (compared with two in 1,014 control chromosomes).

The discrepancy of this result with that obtained by Demerec seems to prove the superiority of the aerosol method for this type of experiment. However, closer inspection of the data makes this doubtful. According to the data shown by Demerec at the Eighth International Congress of Genetics, aerosol treatment with methylcholanthrene produced 25 lethals in 4,671 treated *X*-chromosomes, as compared with 28 in 10,006 control chromosomes, a statistically significant difference. On the other hand, there is no significant difference between Demerec's positive and our negative result in the treated series. It may well be that the feeding method, when done on a comparably large scale, might be as effective in demonstrating the mutagenic capacity of methylcholanthrene as the aerosol method. Whatever method is used, it seems obvious that only experiments involving very large numbers of cultures will be able to reveal mutagenicity in substances of either low mutagenic potency or else low power of penetration to the chromosomes of the germ cells.

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Fungal Mutations Obtained with Methyl Xanthines

IN studying the ability of various chemicals to induce mutations in fungi, we found a very striking effect of the two purine compounds, caffeine and theophylline, which seems to be of interest from several points of view.

Most of the experiments were performed with the ascomycete, *Ophiostoma multiannulatum*, conidia of which were treated with the chemicals under test. Since we looked for specific actions, only clear-cut physiological mutations implying biochemical deficiencies were isolated and identified. The technique is described in another paper[1].

Of the purine compounds tested, caffeine and theophylline showed the strongest activity. An addition of 0·05–0·15 per cent caffeine to a growing conidial culture causes a decrease in the multiplication rate of the conidia. With 0·2 per cent or more of caffeine, growth is completely inhibited, and the conidia are killed at a rate which seems to be a function of the concentration of caffeine present. The corresponding figures for theophylline are 0·2–0·5 per cent and 0·6 per cent respectively.

In platings made from such cultures with inhibited growth, where most of the conidia have been killed, as well as from conidial suspensions in pure caffeine solution, a great number of morphologically deviating monoconidial mycelia appeared.

For certain reasons we chose to examine the possible mutagenic effect of these substances in concentrations which just inhibit the growth, and slowly kill the conidia. It was found that under the experimental conditions, caffeine reached its maximal mutation-producing effect in five days, when 0·2 per cent conidia were still alive. The same seemed to be valid for theophylline.

This technique probably does not exclude the possibility of nuclear divisions (in spite of the inhibited growth), and the mutations found are, therefore, if they are induced, not certainly to be looked upon as 'zero-point mutations' in the sense of Demerec and Latarjet[2].

As appears from the accompanying table, about the same percentage of biochemical mutations was obtained from all the four platings of conidial suspensions treated with caffeine for 5–8 days, namely, c. 1 per cent. Theophylline produced a poorer yield, c. 0·6 per cent. These values are, in comparison with those obtained with other chemicals, very high. X-ray irradiation usually gives in *Ophiostoma* 1·8 per cent biochemical mutations, and nitrogen mustard has sometimes given up to 1·3 per cent. Untreated,

	Number of mutants isolated after treatment with							
	0·2 % caffeine					0·6 % theophylline		
	Treatment in days				Total	Treatment in days		Total
	5	6	7	8		4	6	
Factor required:								
Reduced sulphur	—	—	—	—	—	—	1	1
Arginine	1	3	—	—	4	1	2	3
Lysine	1	1	1	—	3	—	1	1
Methionine	1	—	—	—	1	—	1	1
Other amino-acids	1	—	1	—	2	—	1	1
Hypoxanthine	3	1	1	1	6	—	—	—
Uracil	—	—	—	—	—	—	1	1
Inositol	7	5	5	2	19	2	5	7
Niacin	4	3	—	1	8	—	—	—
Biotin	—	1	—	—	1	—	—	—
Not identified	—	—	—	2	2	1	1	2
No. of mutants	18	14	8	6	46	4	13	17
Conidia isolated	2264	1202	880	398	4744	635	2174	2809
% living conidia	0·20	0·08	0·04	0·03	—	0·38	0·25	—
% mutant conidia	0·8	1·1	0·9	1·5	1·0	0·6	0·6	0·6

growing conidial cultures of *Ophiostoma* from which the conidia for these experiments were taken have never been found to contain more than 0·06 per cent biochemically deficient conidia; in most control experiments none was found.

Of the other methylated purines which we have so far synthesized, only 1,7-dimethyl hypoxanthine has been tested, which produced a weak, statistically not definitely significant, action similar to that described above.

Although it seems most likely that caffeine and theophylline act as real mutagens, as for example nitrogen mustard, the possibility of a selective effect through differential killing has to be considered[3]. A fact that perhaps speaks in favour of this latter interpretation is the distribution of the mutants among the different physiological types, the vitamin-deficiencies (especially inositol-less mutants) being much more numerous than in irradiated or nitrogen mustard treated material[4].

A further elucidation of the phenomenon appears to be desirable for several reasons. Caffeine and theophylline occur in some plants in considerably higher concentrations than those active in our experiments. Of these two substances, at least caffeine interacts, as we have found, in an interesting way in the fungus cell with adenine, one of the chemically closely related amino-purines, which are essential constituents of the nucleo-proteins.

This investigation of the physiological and genetical effects of methyl xanthines, and other purine compounds, is being continued.

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Yeast and Rickets

Some years ago, Brause, Kon and White[1] proved that an addition of high amounts of dried yeast in the ration of pigs produced rachitogenic symptoms. During the feeding practice in our Institute with chickens, we sometimes found that an addition of 2 per cent of dried yeast in the mash (about 1 per cent calculated on the total ration) resulted in a somewhat retarded growth, particularly if the animals did not need the supplement of the B-vitamins provided by this product.

In the light of this experience, we were highly interested in the communication by Hoff-Jørgensen[2], in which he ascribes the unfavourable properties of dried yeast to the presence of a specific phytase-inhibiting substance.

In order to repeat his experiments, we worked with a phytase preparation, made according to the directions of Adler[3]. The splitting of phytin (Ciba) was measured after incubation at 30° C. at *p*H 5·6 for 1–2 hr., by determining the increase in inorganic phosphorus as well as by direct phytic acid–phosphorus determinations. At the beginning of the incubation periods, 50 ml. of reaction mixture contained 12·5 mgm. of phytin and 12·5 mgm. of the phytase preparation. The splitting was calculated as a percentage of the phytic acid originally present.

The yeast extract was prepared by shaking 4 gm. of dried brewer's yeast with 30 ml. of 0·2 *N* hydrochloric acid for 2 hr. The centrifugate was brought with dilute sodium hydroxide to *p*H 5·6 and the volume was made up to 100 ml. 12·5 ml. of this extract (containing approximately 4 mgm. of inorganic phosphorus) was used per 50 ml. of reaction mixture. In addition, determinations were made after adding 4 mgm. of inorganic phosphorus in the form of potassium dihydrogen phosphate.

The results are summarized in the accompanying table.

Percentage splitting of phytic acid after 2 hr. Figures in brackets: after 1 hr.

Buffer	Addition	Splitting (per cent)	
		Calculated from increase in inorganic phosphorus	Calculated from direct phytic acid–phosphorus determinations
Acetate	None	34	66
,,	12·5 ml. yeast extract	20	37
,,	4 mgm. inorganic phosphorus (as KH_2PO_4)	24	39
Citrate	None	38 (23)	87 (47)
,,	12·5 ml. yeast extract	19 (8)	65 (31)
,,	4 mgm. inorganic phosphorus (as KH_2PO_4)	— (10)	65 (32)

As the figures show, we could not confirm the presence of a specific phytase inhibitor in yeast. The inhibition by the yeast extract can be explained fully by taking account of the presence of inorganic phosphorus.

Moreover, it is interesting to note that the results calculated from direct phytic acid determinations are much higher than the results calculated from the inorganic phosphorus determination. This is due to the fact that lower phosphoric acid esters of inositol are not precipitated with the ferric chloride reagent in the circumstances of the McCance and Widdowson method for phytin determination. It shows that the ester bonds in inositol-pentaphosphoric acid, tetraphosphoric acid, etc., are not hydrolysed easier than

the first bond which had been split in the phytin molecule.

Most of the experimental work for this investigation was done by Miss M. W. Muÿen. I am indebted to Dr. J. Grashuis for his interest.

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[1] Brause, R., Kon, K., and White, E. G., *J. Comp. Path.*, **53**, 161 (1943); **54**, 88 (1944).
[2] Hoff-Jørgensen, E., *Nature*, **159**, 99 (1947).
[3] Adler, L., *Biochem. Z.*, **75**, 319 (1916).

USING purified enzyme preparations and certain samples of dried yeast, we have met with the same difficulties as has Dr. de Man in reproducing our first results. We found, however, that the inhibition increased the longer the duration of the experiment, and that the inhibition was considerable when rye bran and dried yeast were incubated together overnight before the adding of the substrate. Experiments show that phosphatases from the bran under these conditions split considerable amounts of inorganic phosphate from phosphoric acid compounds present in yeast. It seems to be this inorganic phosphate which is responsible for our finding of an inhibition of phytase by yeast.

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Stimulation of Adventitious Root Formation by Fungal Metabolic Products

IN an attempt to elucidate the contradicting views concerning the nature and properties of *Fusaria* metabolic products responsible for cotton and tomato wilts, certain substances (stimulating for adventitious root formation) have been detected in the fungal filtrates. These experiments have been originally carried out with the aim of testing the two following points.

(1) The response of healthy cotton cut shoots to the metabolic products of either a specific pathogen (*Fusarium vasinfectum*) or a non-specific pathogen (*Fusarium lycopersici*). Two Egyptian varieties of cotton were used for this purpose: one is a wilt-resistant variety, 'Ashmouni', and the other is a susceptible one, 'Giza 26'.

(2) The response of healthy tomato cut shoots to the metabolic products of either a specific pathogen (*Fusarium lycopersici*) or a non-specific pathogen (*Fusarium vasinfectum*). Two varieties of tomato were used, namely, 'Pritchards' and 'North Dakota'.

The filtrate was obtained by growing the fungus in Richard's solution for twenty-eight days at 30° C. The solution was then freed from the fungus, and was passed through a Berkefeld filter. The fungal filtrate was then divided into three portions: (*a*) a portion was kept unheated; (*b*) a portion was boiled for fifteen minutes; (*c*) a third portion was treated with 96 per cent alcohol. A creamy white precipitate is obtained, which is filtered off and dried; an aqueous solution of the precipitate has been prepared. The remaining precipitate-free filtrate has been distilled under vacuum to remove the excess of alcohol, and was afterwards kept for forty-eight hours at 60° C. to remove the last traces of alcohol.

Freshly cut healthy shoots were dipped in either the unheated or the boiled fungal filtrate, in the solution of precipitate, in the precipitate-free filtrate, or in the precipitate plus the precipitate-free filtrate. Control experiments were also made by using fresh Richard's solution and sterilized tap water. The treated cut shoots were left at ordinary laboratory temperature (18–20° C.) and examined at regular intervals.

An interesting phenomenon has been observed when the cotton shoots (of the resistant 'Ashmouni' variety) were placed in the unheated *Fusarium vasinfectum* filtrate; adventitious roots started to appear on the fourth day (Fig. 1). No similar phenomenon has been seen, however, with the susceptible 'Giza 26' variety on any experimental treatment of the fungal filtrates.

a *b* Fig. 1 — *a* *b* Fig. 2 — *a* *b* Fig. 3

Fig. 1. Cut shoots of 'Ashmouni' cotton growing on: (*a*) boiled *Fusarium vasinfectum* filtrate, and (*b*) unheated filtrate of the same fungus
Fig. 2. Cut shoots of 'Pritchards' tomato grown in: (*a*) aqueous solution of precipitate from *Fusarium lycopersici* filtrate, and (*b*) pure Richard's solution
Fig. 3. Cut shoots of 'North Dakota' tomato grown in: (*a*) aqueous solution of precipitate from *Fusarium lycopersici* filtrate, and (*b*) pure Richard's solution

Unlike cotton, the adventitious root formation, in the cut shoots of the two experimental tomato varieties, was found to be stimulated as a response to the metabolic activity of either the specific or the non-specific *Fusarium* species; the presence of the active principle—responsible for root stimulation—is only restricted, however, to the solutions of precipitates. Although adventitious root formation was induced in both tomato varieties, yet their development in 'North Dakota' was not so vigorous as that of the 'Pritchards' tomato variety (Figs. 2 and 3).

The fungal metabolic products responsible for root stimulation seem to be thermolabile and filterable through a Berkefeld filter. Further detailed studies concerning the possible nature and detailed properties of these substances are still in progress.

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Blood System of the Gut of *Arenicola marina*

During the course of my present investigation into the functional anatomy of the gut of *Arenicola marina*, I have found that Ashworth[1] describes the sub-intestinal blood vessels (sinuses) along part of their length only. He states that these vessels "commence just behind the heart and may be traced to the level of the twelfth setæ, behind which point they disappear". In dissection, with the use of a binocular microscope, it is possible to trace out these vessels, which have been renamed the sub-enteric vessels, along the whole length of the gut. Indeed, they are visible with the naked eye. This observation I believe to be of importance as it shows that the same basic pattern underlies the blood system in all parts of the gut. Serial sections have confirmed this point.

The blood system of the gut of the lugworm appears to be as follows.

The dorsal vessel runs along the dorsal surface of the gut, starting as a network of vessels near the anus and dividing into several branches under the prostomium. Along its entire length this vessel gives off branches to the complicated blood-sinus system lying in the walls of the gut.

The ventral vessel runs underneath the gut beginning as a plexus of vessels surrounding the proboscis and breaking down into a plexus near the anus. This vessel, unlike the dorsal vessel, has no connexion with the blood sinus of the gut.

Four definite longitudinal tracts can be distinguished in the blood plexus in the gut wall: (*a*) two sub-enteric vessels; (*b*) two lateral enteric vessels. The former are very fine and run along the gut from the œsophagus to the anus on either side of the mid-ventral line. The latter are confined to the œsophagus and the front half of the stomach. In segment 7 the lateral enteric vessels are enlarged to form the 'auricles' which pulsate. The enteric vessels communicate on either side with the ventral blood vessel by two thick-walled muscular ventricles.

The four longitudinal tracts are linked to each other and with the dorsal vessel by means of primary transverse tracts, which lie between the rows of pouches in the stomach region. The primary tracts are linked with one another by finer secondary tracts.

The work mentioned here was carried out partly at University College, London, and partly at the Imperial College of Science and Technology, under the supervision of Mr. G. P. Wells, to whom I tender my sincere thanks.

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[1] Ashworth, J. H., L.M.B.C. Monograph "Arenicola" (1904).

Extrafloral Glands of Cucurbitaceæ

I have already pointed out[1] that quite a good number of species of Cucurbitaceæ are provided with well engineered devices for exudation of surplus water and waste substances. These plants, being primarily moisture loving, have structures especially suited to exudation of aqueous fluids which are absorbed in quantity in excess to the requirement, physiological conditions being very favourable for rapid absorption. The genera *Coccinia*, *Luffa*, *Lagenaria*, *Momordica*, *Cucurbita*, etc., develop extrafloral nectaries. In *Coccinia cordifolia* (Linn.) Cogn. a few glistening glands are present on the lamina round about the basal region of the midrib on the adaxial leaf surface; in *Luffa acutangula* (Linn.) Roxb. and *L. cylindrica* (Linn.) Roem. these glands are often found scattered all over the lamina besides a special fleshy glandular probract being developed at the base of the peduncle of the male and female inflorescences; in *Lagenaria vulgaris* Ser. (*Lagenaria leucantha* (Duch.) Rusby) two bilateral glands are present at the remote end of the petiole and in *Momordica cochinchinensis* (Lour.) Spreng. a few are found at the petiole end or on the lateral marginal costa at the leaf-base; in *Cucurbita pepo* Linn., *C. maxima* Duchesne and *C. moschata* Poiret minute club-shaped glands do develop at the abaxial leaf surface.

The structure of the extrafloral glands is well planned for efficient discharge of waste substances. The essential parts of a gland are the: (1) supply tissue (Figs. 1 and 2, *ST*), (2) filter tissue (Figs. 1 and 2, *FT*), and (3) external excretory tissue or osmotic tissue (Figs. 1 and 2, *ET*). The conducting elements—the vessels and the tracheids—are arranged all round the glands for translocation of catabolic substances in solution to the vital supply tissue. This supply tissue is made of somewhat elongated cells with a distinct nucleus in each cell. As the supply tissue is charged with sufficient fluid, it filters through the single-layered lignified bilaterally thickened

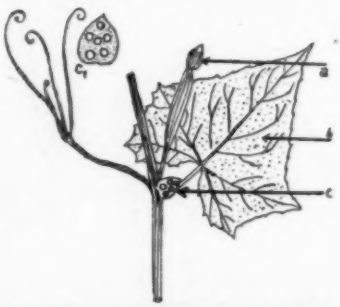

Fig. 1. Portion of a flowering branch of *Luffa acutangula* (L.) Roxb. (*a*) Female flower; (*b*) leaf; (*c*) glandular fleshy probract (× 1); (c_1) probract (× 2)

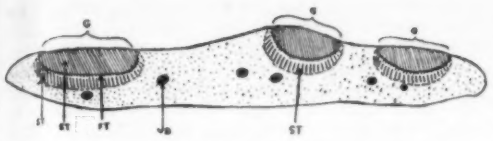

Fig. 2. *Luffa acutangula* (L.) Roxb. Transverse section of a probract passing through three glands (diagrammatic, × 20). *G*, Gland; *V.B.*, vascular bundle; *F.T.*, filter tissue; *E.T.*, external osmotic tissue; *S.T.*, supply tissue

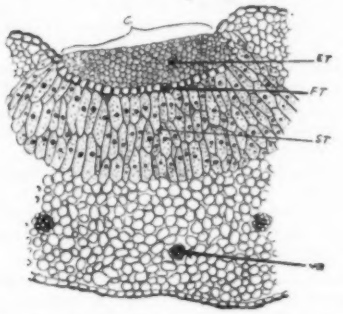

Fig. 3. *Luffa acutangula* (L.) Roxb. Transverse section of a part of the same probract as in Fig. 2. (× 100)

G, Gland; *V.B.*, vascular bundle; *F.T.*, filter tissue; *E.T.*, external osmotic tissue; *S.T.*, supply tissue

filter tissue. An interesting biological significance is attached to this characteristic filter tissue having selective influence on the exudate. Filter tissue guards against the passage of essential nutritive substances through it and permits only waste substances to filter through. The activity of secretion is greatly influenced by the presence of sugar in the secreting cells which acts as osmotic substance. (The sugar is obtained by photosynthesis.) The rate of secretion is also greatly influenced by temperature and sunlight. The secretory activity increases with the rise of temperature and decreases with the fall of it. Most active secretion is marked during the warmer part of the day.

That the extrafloral nectaries are concerned with the vital functions of the plant is evident, due to their presence in the developing organs of the plants. The sugary secretion from the gland also attracts ants and insects and possibly helps in the biology of pollination. Ants are the commoner visitors. They probably perform a defensive function too.

The investigation is in progress, and details will be published in due course.

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[1] *Philippine J. Sci.*, **63**, No. 4, 426 (1937).

New Colour and Fluorescence Reactions in the Steroid and Synthetic Œstrogen Series

By using suitable solvents as diluents in the reaction mixture to modify the phosphoric test for natural œstrogens[1], new and apparently specific colour or fluorescence tests have been found for *trans trans* $\Delta^{3:6}$-androstenediol-3 : 17, dienœstrol, 17-ethinyl œstradiol, 17-methyl androstenediol-3 : 17, *d-l*-equilin, œstriol, 16-keto œstradiol, œstrololactone acetate, and Westerfeld's lactone acetate. The use of low temperatures in two of these reactions may be advantageous in the examination of biological extracts. Conditions have been found for the quantitative estimation of androstenediol and dienœstrol. Further work on the quantitative estimation of the other compounds is in progress and will be published elsewhere.

Series A. Natural œstrogens and related phenols. The compound dissolved in 0·2 c.c. glacial acetic acid is mixed with 1·8 c.c. 88 per cent w./w. phosphoric acid, allowed to stand at room temperature for at least one hour prior to dilution with 3 c.c. cold glacial acetic acid. Resulting colours and fluorescence are noted before and after dilution with acetic acid. Some of the results are shown in the accompanying table. Œstriol gives a much more intense green fluorescence if propylene glycol is substituted for acetic acid and the mixture heated at 100° C. for ten minutes. Similar heating with acetic acid instead of propylene glycol gives a mauve-coloured solution with a pale greyish-blue fluorescence in ultra-violet light.

Substance	Colour of fluorescence in ultra-violet light	Comments
(Estrone, equilenin, dihydroequilenin	Green	
α-Œstradiol	Blue-green	
16-keto-œstradiol	Light-green	
3-Hydroxy-16-keto-equilenone	Yellow-green	Oxygen at 17 position is not necessary for fluorescence development
Δ 14 : 15-Hydroxy-16-ketoequilenone	,, ,,	,, ,,
1-Keto 2-methyl 7-hydroxy 1.2.3.4-tetrahydrophenanthrene 2-acetic acid	Light-green	Steroid structure not essential for green fluorescence.
β-Naphthol	Weak-green	,, ,,
α-Naphthol	No appreciable fluorescence	
17-Ethinyl œstradiol	Orange	Fluorescence is rapidly quenched during addition of more acetic acid. A deep pink unstable colour then develops
d-l-Equilin	Pink, with additional acetic acid	Blood-red colour. Stable for many days
Acetate of Westerfeld's lactone	Brilliant green-blue on heating (with additional acetic acid) at 80° C. 5 min.	On addition of the cold acetic acid a pale pink colour developed
Acetate of Jacobsen's œstrololactone	,, ,,	No pink colour was obtained as for Westerfeld's lactone
Stilbœstrol, hexœstrol, *p*-hydroxypropiophenone	No green	
Dienœstrol	Deep blue	Technique of Series B used

Series B. Quantitative procedure for dienœstrol. 25–100 μgm. of dienœstrol dissolved in glacial acetic acid is mixed with 1·8 c.c. 85 per cent phosphoric acid. A sequence of yellow, orange, orange-pink and pink colours develops on standing at room temperature for one hour. Subsequent heating at 100° C. for one hour followed by addition of 3 c.c. of acetic acid and re-heating for a further hour results in the quantitative formation of a bluish-purple colour. An intense violet-blue fluorescence is also given. Hexœstrol, stilbœstrol, hydroxybenzoic acids and pyrocatechol do not give this reaction, but *iso*dienœstrol gives a similar colour. The presence of excessive amounts of *p*-hydroxybenzoic acid interferes with the quantitative determination of dienœstrol.

Series C. Non-phenolic steroids. 25–250 μgm. of androstenediol dissolved in 0·2 c.c. glacial acetic acid is mixed with 1·8 c.c. 85 per cent phosphoric acid, warmed at 55° C. for fifteen minutes, cooled and diluted to 5 c.c. with glacial acetic acid. After standing at room temperature in the dark for seventy-five minutes a violet colour and violet fluorescence (ultra-violet) develops.

This colour reaction appears to be specific for androstenediol and is not given by cholesterol, pregnandiol, cholic acid, 17 ethinyl androstenediol, progesterone, desoxycorticosterone acetate, pregnenolone, $\Delta^{5:6,\ 16:17}$-pregnanedienolone 3 : 20, *trans* testosterone and methyl testosterone. *trans trans* Methylandrostenediol 3 : 17 gives a bright green fluorescence with very little colour, whereas dehydroandrosterone gives an unstable deep pink colour.

Conditions influencing the ease and degree of dehydration of the compounds under test are evidently of considerable importance in the development of colour and fluorescence.

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[1] Finkelstein, M., Hestrin, S., and Koch, W., *Proc. Soc. Exp. Biol. Med.*, **64**, 64 (1947).

Fermentation of Pyruvate, β-Hydroxybutyrate and of C_4-dicarboxylic Acids by some Butyric Acid-forming Organisms

According to several authors, pyruvate is an intermediate in the formation of C_4-compounds in the butanol-acetone fermentation. According to others, pyruvate is not such an intermediate and gives rise only to acetate when fermented by resting cells of butyl organisms. The different results obtained by the various authors can be explained by the utilization of different strains. Thus, we have observed that washed cells of the strain *GR*4 of *Clostridium saccharobutyricum* Schattenfroh and Grassberger, when acting on pyruvate, give rise to acetate and butyrate. The same results are obtained with suspensions of *Cl. acetobutylicum* (Weizmann) McCoy, Fred, Peterson and Hastings, strain *Fd*11, whereas strain *PC*48 and some other strains of the same organism give rise only to acetate when acting on pyruvate. These last strains may need a coupled reaction to ferment pyruvate in the normal C_4-compounds.

M/1,000 arsenite totally suppresses butyric acid formation from pyruvate with those strains able to give both acetate and butyrate from pyruvate[1]. The total volatile acid is about 30 per cent lower in the presence of arsenite than in the controls, but only acetic acid is formed. This suggests a possible transformation of acetate into butyrate during normal fermentation. Such a transformation has been found to occur in cultures in experiments using carbon-13 by Wood, Brown and Werkman[2]. Further experimental evidence for this fact has been adduced by us on the course of pyruvate fermentation by resting cells. At the beginning of the experiment, pure acetic acid was obtained, while the ratio butyric/acetic acid eventually reached 1/1 and even 2/1 (Duclaux distillation data).

Acetate alone, or in the presence of hydrogen (with and without phenosafranine), does not give rise to butyrate.

Peldàn[3] suggested that β-hydroxybutyrate could be an intermediate in the formation of butyric acid. We have found that this compound is readily fermented at *p*H 7 by washed suspensions of all the strains of *Cl. saccharobutyricum* and *Cl. acetobutylicum* tested, whether or not they were able to form butyrate from pyruvate. The volatile acid products of this fermentation were acetic and butyric acids in the ratio 1/1, independently of the time of incubation. Butyrate formation from β-hydroxybutyrate is unaffected by arsenite. Our results on β-hydroxybutyrate fermentation do not agree with the conclusions drawn by Johnson, Peterson and Fred[4] from their studies on growing cultures.

Our strains, in accordance with the findings of Simon and Weizmann[5], do not ferment succinate. On the contrary, fumarate, oxalacetate, and to a lesser extent, malate, are well fermented to butyric and acetic acid by *Cl. saccharobutyricum* (strain *GR*4).

We propose as a working hypothesis the following scheme for butyric acid formation:

pyruvate → acetate → unknown intermediates → β-hydroxybutyrate → acetate + butyrate.

According to this hypothesis, arsenite acts on a stage anterior to the formation of β-hydroxybutyrate.

A detailed account of the experiments will shortly be published elsewhere.

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May 20.

[1] Cohen-Bazire, G., Cohen, G. N., Nisman, B., and Raynaud, M., *C.R. Soc. Biol.* (in the press).
[2] Wood, H. G., Brown, R. W., and Werkman, C. H., *Arch. Biochem.*, **6**, 243 (1945).
[3] Peldàn, H., *Biochem. Z.*, **309**, 108 (1941).
[4] Johnson, M. J., Peterson, W. H., and Fred, E. B., *J. Biol. Chem.*, **101**, 145 (1933).
[5] Simon, E., and Weizmann, C., *Enzymologia*, **4**, 169 (1937).

British Abstracts

In my section of the account published in *Nature* of August 21 of the Royal Society Scientific Information Conference, I stated that *British Abstracts* were of the 'indicative', that is, a briefer type; other abstracts were of the 'informative', that is, a longer type. That is how those various services describe the abstracts they publish. Fear has been expressed lest those unfamiliar with *British Abstracts* or with the use of these words, 'indicative' and 'informative', in this connexion may infer that *British Abstracts* differ radically from all the others, and may be even merely extended titles. This, of course, is not so.

The papers circulated to the Conference explained that an 'indicative' abstract aims at giving the reader sufficient information to decide whether he should read the original paper or not, and that while the 'informative' abstract is usually longer and contains more data, many of the abstracts published by the 'informative' services are of the 'indicative' type.

I am left with some doubt, however, regarding the aptness and usefulness of these words in this connexion.

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HEXOSAMINE COMPONENTS OF THE HUMAN BLOOD GROUP SUBSTANCES

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FOR some time past we have been engaged on the isolation and characterization of the specific blood group substances which belong to the *ABO*[1] system. The identification of the component molecules of these complex mucoids has been delayed until satisfactory evidence for the homogeneity of the substances was obtained. On the basis of the results of measurements which have involved the physical, chemical and immunological properties of the human group *A*-substance, we consider that this material has now been obtained as a homogeneous complex. Full details of its preparation and properties will be given elsewhere[2].

The partial and complete hydrolysis products of the homogeneous *A*-substance have been investigated, and during the examination of the amino-acid components by means of two-dimensional paper partition chromatography[3], using collidine and phenol-ammonia as solvents, it was observed that two of the thirteen spots which developed on treatment of the paper with ninhydrin could not be identified with those expected from known amino-acids. It is well known, however, that the hexosamines, glucosamine and chondrosamine, of which glucosamine has already been identified as a component of the *A*-substance, react with ninhydrin under the conditions of the test to give a greyish-mauve area indistinguishable from the coloured areas which arise from the majority of amino-acids.

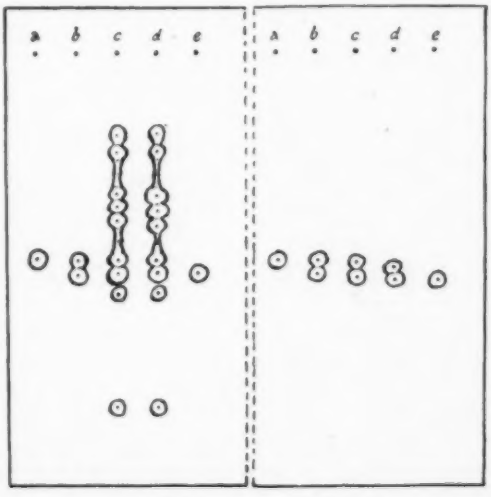
The colour reaction of the amino-sugars, glucosamine and chondrosamine, with a modified Ehrlich's reagent after treatment with an alkaline solution of acetylacetone under carefully controlled conditions has been used for the quantitative determination of these hexosamines[4], and has recently been extended to their detection in paper chromatography[5]. Using this reagent with the *A* hydrolysis products, two cherry-red spots were obtained corresponding in position to the two unknown ninhydrin spots.

A two-dimensional paper chromatogram using collidine and phenol-ammonia (0·6 per cent w./v. ammonia and coal gas) as solvent systems on the hydrolysis products (1 mgm.) of *A*-substance (16 hr. 6 *N* hydrochloric acid at 100°), to which 0·1 mgm. each of glucosamine and chondrosamine hydrochloride were added, resulted in no additional spots appearing when the paper was developed with ninhydrin. A similar chromatogram produced simultaneously with glucosamine (0·1 mgm.) and chondrosamine (0·1 mgm.), but developed with the hexosamine reagents in place of ninhydrin, revealed two areas corresponding in position to the two unidentified ninhydrin spots. It seemed probable, therefore, that the two unidentified ninhydrin spots were due to glucosamine *and* chondrosamine.

Two additional chromatograms using the acid hydrolysis products of the human *A*-substance were run with (*a*) collidine and *n*-butanol-ammonia (3 per cent w./v. ammonia) and (*b*) collidine and *n*-butanol-water as solvents. Both chromatograms showed two ninhydrin spots which, however, were not due to methionine or tyrosine, which have the same R_F value in these solvents, because two similarly placed cherry-red spots were obtained on another sheet run simultaneously and sprayed with the hexosamine reagents. The separation of the two hexosamines in butanol is poor; but with butanol-ammonia and with collidine a useful resolution is obtained.

These observations were correlated by making a run with collidine as solvent on a single sheet of Whatman No. 1 paper. Along the width of the paper, ten positions were marked out and the following substances (or mixtures) were put on the paper and run with the solvent for 72 hr.: (*a*) chondrosamine hydrochloride, (*b*) chondrosamine and glucosamine hydrochlorides, (*c*) acid hydrolysis products of *A*-substance with (*b*) added, (*d*) acid hydrolysis products of *A*-substance alone, and (*e*) glucosamine hydrochloride. The series was repeated on the remaining half of the paper. The paper was then dried and cut into two along the dotted line (see figure); one half was sprayed with the ninhydrin reagent and the other half with the hexosamine reagents. The coloured areas which developed are shown diagrammatically. There seemed strong evidence for believing that both amino-sugars were present as components of the *A*-complex.

N-acetylglucosamine and *N*-acetylchondrosamine give no colour with the ninhydrin reagent, move faster than the corresponding bases and yield a mauvish-pink colour with the hexosamine reagents. *N*-methyl-L-glucosamine, a component of streptomycin[6], has an R_F value in collidine only slightly greater than glucosamine, but its colour reaction with ninhydrin—a pale pink colour forming after heating at 80–90° for a few minutes—is in marked contrast to that shown by glucosamine and chondrosamine and by the 'unidentified' spots which arise from the hydrolysis products of the group *A*-substance. Again, under the test conditions with the hexosamine reagents, *N*-methyl-L-glucosamine develops a mauvish-pink colour, reminiscent of coloration which arises from the acetylhexosamines and very different from the cherry-red colour given by the hexosamines.



A. Chromatogram developed with ninhydrin reagent.
B. " " " acetylacetone followed by Ehrlich's reagent

It has been observed that treatment of the paper with collidine or phenol, but not butanol, seems to suppress its reaction with the ninhydrin and hexosamine reagents. Thus, although the chromatographic data do not completely rule out the possibility of the presence of N-methyl-L-glucosamine, this substance is certainly not responsible for either of the hexosamine spots obtained.

Partridge[5] examined by the chromatographic technique the sugar components of an inhomogeneous preparation of *A*-substance obtained from gastric mucin[7] and concluded that chondrosamine was not present.

To summarize the evidence for the occurrence of glucosamine and chondrosamine in the group *A*-substance, it may be stated that as a result of examining the complete acid hydrolysis products of the substance on paper chromatograms, two spots which occur close together are detected with three different reagents: (*a*) ninhydrin, (*b*) ammoniacal silver nitrate[8] and (*c*) the hexosamine reagents. All three reagents detect the hexosamines but under the test conditions exclude the presence of the N-acetyl derivatives and N-methyl-L-glucosamine. The two spots have R_F values identical with glucosamine and chondrosamine in (*a*) collidine, (*b*) phenol-ammonia, (*c*) *n*-butanol, and (*d*) *n*-butanol-ammonia (3 per cent w./v.). The addition of glucosamine and chondrosamine to the hydrolysis products of *A*-substance results in the development of no additional spots irrespective of the reagents used for development. Treatment with zeolite resulted in the removal of glucosamine and the unknown material[7] as determined by ammonia–silver nitrate reagent. Fractional precipitation of the *A* hydrolysis products with acetone and ether results in the separation of material which when tested on paper strips gives rise to two spots which are considered to be due to the presence of glucosamine and chondrosamine.

Preparations of the *A*- and *H*-substance[9] (the so-called '*O*' substance) obtained from pig gastric mucin, and partially purified *H*-substance isolated from human pseudo-mucinous cyst fluids, also show the presence of the two hexosamine spots.

An examination of the relevant literature shows that in many instances the amount of glucosamine isolated from the hydrolysis products of mucopolysaccharides and mucoids represents only a small part of the total hexosamine estimated to be present by the colorimetric method. For example, Meyer, Smyth and Palmer[9] isolated about 30 per cent of the total hexosamine present in a preparation of the neutral polysaccharide of pig's gastric mucosa, whereas from the acid mucopolysaccharide co-existing in this tissue a yield of more than 90 per cent of the hexosamine present was obtained. Several procedures have been devised for the isolation of glucosamine which give excellent yields of this amino-sugar[10], but in spite of the application of these methods to the hydrolysis products of some mucopolysaccharides poor yields of glucosamine have been obtained. In view of the difficulty of isolating chondrosamine, however, it is suggested that in certain instances the poor yields of isolated glucosamine might well be due to the presence of a second amino-sugar, and a re-examination of the nature and amount of the 'hexosamine' component in these materials is suggested.

The identity of the second hexosamine present in the blood group substances with chondrosamine is not conclusively established by the evidence presented in this communication, and the claim that it is a component must await the isolation of one or more crystalline derivatives identical with the corresponding derivatives of an authentic specimen of chondrosamine. We are now engaged on obtaining this evidence.

We are indebted to Prof. M. L. Wolfrom for a sample of N-methyl-L-glucosamine.

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VOLATILE CUPROUS AND SILVER SALTS OF FATTY ACIDS

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In a communication in *Nature*[1], one of us (F. K.) reported on a volatile copper compound obtained by thermal decomposition of cupriformate. J. G. Maltby[2] directed attention to the work of A. Angel and A. V. Harcourt[3], according to whom cuprous acetate forms as a white sublimate when cupri-acetate is heated.

We succeeded in isolating the volatile product of decomposition of cupriformate, and microanalytical determinations proved that it was cuprous formate. Our previous assumption that the 'volatile' compound was present in the form of vapour or gas in the gas streaming over the decomposing cupriformate was erroneous. Passage of the gas through layers of 5–30 mm. length of cotton wool, glass wool or asbestos revealed that we had been dealing with an extremely fine aerosol which could be 'developed' by chemical methods along the stopping layer, for example, with hydrogen sulphide as brown-black cuprous sulphide. The distribution of colour along the layer gave the impression of decreasing exponentially along its length. The aerosol also acted on saturated vapours, forming condensation centres.

By causing turbulent flow of the transporting gas, for example, by blowing it against a wall or into a reversed capillary, we obtained a white deposit of this aerosol which showed the following reactions: (1) water or water vapour decomposed it into a yellow solid (cuprous hydroxide) and formic acid; (2) acids decomposed it into a red insoluble powder of metallic copper and blue cupriformate; (3) it sublimes *in vacuo* between 100° and 105° C. but begins to decompose already at 105° C. (this may account for the fact that Kohlschütter[4] failed to detect it in his detailed work on cupriformate decomposition, because he worked at about 200° C.); (4) because it is decomposed by water and acids (1 and 2), it was difficult to collect sufficient pure material for analysis, since water and formic acid are among the primary decomposition products of the cupriformate. The gas had to be dried with calcium chloride and neutralized with layers of potassium carbonate which occluded most of the aerosol. However, it was possible with extreme precautions to prepare samples of 3–8 mgm. and to determine iodometrically their copper content and bromometrically their formate content, after having duly identified the latter by the calomel and silver reduction methods. Naturally, Cu and $HCOO^-$ were separated from each other before determination. The results agreed within 2–4 per cent with the theoretical values for cuprous formate (CuHCOO).

The only mention of this substance in the literature is to be found in A. Angel's paper[5], who obtained it from solution. We found that the formation of white cuprous compounds which sublime is a general property of cupric fatty acid salts: the acetate, propionate, valerate behaved in a similar manner; laurate and stearate, though melting and carbonizing, yielded mirrors also, indicating a similar decomposition of these salts as well. The cuprous compounds were all very prone to thermal decomposition into metallic copper. They also reacted with water and acids like the formate (reactions 1 and 2):

$$Cu.HCOO + H_2O \rightarrow CuOH + HCOOH \quad (1)$$

$$2Cu.HCOO \xrightarrow{H} Cu(HCOO)_2 + Cu. \quad (2)$$

An old Liebig combustion tube, when heated gently while a stream of nitrogen passed through it, showed copper mirror formation at several points and a white deposit was formed at the end of the tube, where the temperature was about 100° C. The latter looked like cuprous formate and gave all its characteristic reactions. This fact seems to explain former observations on volatile copper in combustion tubes, which originally contained no fatty acids, though traces of other organic compounds were present, of which fatty acids—most probably formic acid—might arise through heating by the catalytic action of copper.

We also prepared the fatty acid salts of silver, taking care to avoid decomposition of the formate by immediate washing of the precipitate. The formate explodes with intense detonation on heating to 90–100° C.; it was necessary to mix it with indifferent powders to avoid detonation. All these salts could be made to sublime *in vacuo* using a micro-technique with extreme precaution. The analogy with the cuprous compounds seems to be perfect. Some tentative experiments with gold hydroxide in a stream of warm formic acid vapour looked as if there had been miniature explosions and mirror formation; however, we do not wish to insist upon the reality of these observations.

The analogy of silver and cuprous formate gave us the key to the quantitative study of thermal decomposition of the copper formates. First of all, we determined the gas reaction products of the decomposition of silver formate and found that it agrees with the following reaction:

$$2Ag.HCOO \rightarrow H_2 + 2CO_2 + 2Ag$$

within about 5 per cent, of which 1 per cent was methane, somewhat less carbon monoxide and the rest unidentified. Traces of water could also be observed. We assume that cuprous formate, which could not be prepared in a quantity sufficient to study this reaction, decomposes in the same manner.

On the other hand, we determined the decomposition products of 1 mol. of the thermally decomposed cupriformate, and found as average a relative error of about 5 per cent for carbon dioxide and formic acid and an error of 10–15 per cent for the rest:

0·97 mol. per cent carbon dioxide
0·84 mol. per cent formic acid
0·10 mol. per cent hydrogen
0·08 mol. per cent water (approximately)
0·05 mol. per cent carbon monoxide ,,

This accounts for 102 per cent hydrogen, 93 per cent carbon and 94 per cent oxygen. The results indicate clearly that the main line of decomposition (say, 80 per cent) must follow the reaction:

$$Cu(HCOO)_2 \rightarrow Cu + HCOOH + CO_2.$$

Only a side branch of the decomposition can go through cuprous formate if we assume that (1) its decomposition is analogous to that of silver formate, and (2) all hydrogen found is formed from this cuprous salt:

$$2CuHCOO \rightarrow 2Cu + H_2 + 2CO_2.$$

In this case the excess of carbon dioxide with respect to formic acid should be double the molecular percentage of hydrogen, while actually 1·3 mol. were found; but the experimental errors may account for the difference. Roughly, 15 per cent of the original cupriformate would have reacted in this event to yield cuprous formate, and it can be stated with reasonable certainty that the reaction taking place is:

$$2Cu(HCOO)_2 \rightarrow 2CuHCOO + HCOOH + CO_2.$$

There is, however, a possibility of the following reaction:

$$2Cu(HCOO)_2 \rightarrow 2CuHCOO + H_2O + CO + CO_2.$$

The presence of carbon monoxide and water could be taken as indication of the second reaction, but the fact that the carbon monoxide obtained was approximately half the hydrogen found may indicate that it is only one of several reactions occurring. We should not forget that Kohlschütter found a small quantity of hydrocarbons among the decomposition products; this may have been synthesized by catalytic action of the highly disperse copper from the primary products. We found only insignificant traces of formaldehyde among them.

On the hypothesis that the direct decomposition of cupriformate yields copper powder and that decomposition through intermediary cuprous formate is responsible for the formation of the copper mirror on the wall of the reaction vessel, we tried to separate

these two forms of copper and found that there is certainly not more than 25 per cent copper in the form of the mirror. It may have been considerably less, in accordance with the above calculation.

The nature of the 'volatile copper compound', or more correctly 'compounds', is therefore definitely established, and the main lines of thermal decomposition of cupri-, cuprous and silver formate are determined with reasonable certainty.

A detailed account of the work will appear in *Magyar Technika*.

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ENGINEERING STUDENTS AND MATHEMATICS

ON the morning of September 14, at a joint session of Sections A (Mathematics) and G (Engineering) of the British Association, a discussion took place upon the subject of "Applicable Mathematics".

Wing-Commander T. R. Cave-Browne-Cave (president of Section G) in his opening remarks emphasized that mathematics is a matter of importance, but often of difficulty, to engineering students.

Mr. D. N. de G. Allen (Mathematics, Imperial College of Science and Technology, London) said he spoke as one engaged in teaching mathematics mainly to undergraduate and postgraduate engineering students. He would consider not the oft-asked question: "What does the engineer require of mathematics?", but rather "What does his mathematics require of the would-be engineer?" Mathematics is an integral part of engineering science, evolved to satisfy the demands of engineering, and should be used by the engineer as one of the tools of his trade. The obstacles the engineer has to overcome are: first, the fact that his problem is stated in engineering terms, and must at the outset be translated into mathematical terms; secondly, the mathematical problem must be set up; thirdly, a mathematical solution must be found; fourthly, this solution must be translated back into an engineering solution. In stage one it is desirable that *all* the available data be explicitly stated. In stage two it is especially important to realize whether the mathematical problem is, or is not, complete in itself. In stage three the maximum possible use should be made of simple ideas, simple methods, and simple functions. In particular, numerical methods, which enable formerly intractable problems to be solved by simple arithmetic, using processes which are intelligible at every step, have great merit, at postgraduate as well as at undergraduate level. At the same time, however, the more advanced mathematical methods should not be entirely overlooked; the engineer should be aware of the existence of such methods, and should know when, and how, to consult the mathematical expert.

Dr. J. A. Pope (Engineering, University of Sheffield) pointed out that engineering, a branch of applied science the object of which is to create objects of immediate utility, calls upon many branches of science; and while the engineer could not be expected to have a detailed knowledge of all these branches, he must know enough to be able to appreciate the significance of the information supplied by the specialist. But engineering is also a delicate balance between tradition and the application of scientific knowledge, the 'factor of safety' representing the traditional element in design. Turning to mathematics, he suggested that any mathematical process which the engineer is prepared to adopt must be susceptible of a physical interpretation, and this, indeed, at every stage. Another necessity for the engineer is 'pictorial vision', and this can be both aided and exploited by copious use of graphical methods in teaching mathematics; abstract ideas can with advantage be handled by means of graphical representation, for example, vector diagrams, and the Argard diagram for complex quantities involving $i = \sqrt{(-1)}$. After brief reference to some essential elements, such as power and Fourier series, integration, partial differentiation, and differential equations, the advantages of numerical methods (step-by-step and 'relaxation') were mentioned, and the necessity of some more advanced mathematics for the abler men was pointed out. But there is a difference in intellectual make-up between the mathematician, master of abstract thought, and the engineer, servant of practical necessity. This has sometimes led to barbarous treatment of mathematical lecturers by otherwise well-behaved engineering students, and to a 'pearls before swine' attitude on the part of some of the former.

Mr. F. S. Snow (president, Institution of Structural Engineers)—whose contribution was read for him on account of illness—referred more particularly to the extent to which the average engineer needs to utilize mathematics in the solution of day-to-day problems. The more experienced an engineer, the less mathematics he personally uses in his day-to-day business. He is, however, able to use the mathematics he learned as a student when necessary, and knows where to turn for the more advanced methods. But the experienced engineer will not profess to be able to design, say, a reinforced concrete column by eye alone, and he will employ younger engineers, and perhaps even mathematicians, to perform the calculations inseparably connected with design. For these, familiarity with mathematics, at least as far as the calculus, is essential. From time to time, new theories based on new assumptions are produced, usually by the mathematicians, and at first the engineer must rely upon the resulting formula; reinforced concrete shell roofs are an example. On the other hand, the practical engineer is faced with uncertainty as to data, as to the properties of many of the materials he uses, and as to the excellence (or otherwise) of the workmanship. Mathematically elegant designs may be scrapped because they demand a higher standard of workmanship than is generally available. Thus, while all engineers should attain a standard in mathematics at least as high as that prescribed by the professional institutions, they require also to amass a vast amount of experience.

Dr. A. G. MacFarlane (Telecommunications Research Establishment, Malvern) devoted himself to a particular, rather than a general, aspect of the subject under discussion, namely, the calculus of variations and its usefulness as a method for the solution of physical and engineering problems. He referred to the development of the principle at the end of the eighteenth and beginning of the nineteenth

centuries as outstanding, the most important feature being Hamilton's demonstration that the equations of dynamics might be derived from a stationary principle. As a result, variational principles now occupy a central position in theoretical physics, but are still not used as much as they might be. Most problems must be idealized before they become tractable, but the more powerful the mathematical technique, the less the amount of idealization necessary; it is therefore desirable to review all the possible methods when tackling any problem. Most physical problems are usually stated mathematically in terms of differential equations and boundary conditions. But differential equations are 'local', and use of integrals is advantageous, because they include the behaviour of the functions over the whole range of variables, and also because they incorporate the boundary conditions. Such methods are (1) integral equations, (2) variational principles. Using for illustration the diffraction of electromagnetic waves by a slit, the advantages of the variational methods were outlined. The variational equations may be solved, for example, by Ritz's method or by 'relaxation'. Another advantage is that the integral which is to be made stationary usually represents a quantity of great physical significance.

Prof. W. G. Bickley (Mathematics, Imperial College of Science and Technology, London) said that the opening speakers had considered the mathematical education of the ordinary engineer, and the mathematical needs of the extraordinary engineer, in what seemed to him about the right proportion, and had underlined the fact that the problem exists at two levels. At the lower level the problem is not so much *what* to teach, as *how* (and to some extent *when*) to teach it. Following up Mr. Allen's emphasis upon the necessity of translating from the language of engineering to the language of mathematics, he stressed the desirability of the lecturer in mathematics being able to speak the engineer's language. One of the greatest obstacles in the way of the enlightened mathematician is the still too prevalent attitude that mathematics should be avoided like a plague, instead of used to increase efficiency. It is inconsistent to advocate modern machine tools in the workshop, and fall back upon the equivalent of cold chisel and file for thinking. So absurd, indeed, that he wondered whether the mathematicians had always given the engineering students a fair deal, whether the barbarity referred to by Dr. Pope was partly their fault—if there was a 'pearls before swine' attitude, then barbarity was just retribution. Speaking of engineering students as amenable to sympathetic treatment, and of teaching them mathematics as a rewarding and enjoyable task, he urged his mathematical colleagues to take this task seriously. Familiarity with the mathematical chapters of the engineering text-books would give much food for thought, in more ways than one. Improvements were, of course, being made, and he instanced the work of a sub-committee set up by the Mathematical Association. But education is a slow process. Perhaps some of his students, becoming lecturers in engineering, might condition the minds of their students to more and better mathematics.

Turning to the high-level problem, Prof. Bickley said two things are necessary—to be able to give a 'top-dressing' of applicability to the graduate mathematician, and a top-dressing of mathematics to the abler graduate engineer. For this a central "Institute for Applicable Mathematics" is desirable. Attached to a university, but maintaining close contact with research institutions, with a staff collectively conversant with classical and modern mathematics, mathematical physics and technology, interested in seeing where and how mathematics has aided and can aid the scientific worker and technologist, such an institute would so equip its students that they might fit very quickly into any research institution or could become teachers in the technical colleges and universities. Part-time and refresher courses, for those already engaged in research or teaching, would also be provided. Indeed, the principle had been agreed, but lack of funds has prevented a start being made. Could industry, perhaps on a co-operative basis, come to the rescue? If so, the outlay would earn rich, if perhaps indirect, dividends.

Sir Richard Southwell remarked upon the friendliness of the discussion. He thought this a good thing, because in his opinion there *is* a fundamental difference of outlook between mathematician and engineer, in consequence of which they would have to agree to differ—and agreement to differ is possible only between friends. He gave some illustrations of the difference of outlook. As regards calculus of variations, he thought that many engineers were already familiar with examples of the idea, for example, minimum strain energy as a basis for analysis of structures. Many abstract ideas could be assimilated if they were approached through concrete examples, and he agreed with Dr. Pope's emphasis upon keeping the physical meanings in view. He also instanced Rayleigh's use of variational methods for deducing governing equations throughout his great "Theory of Sound".

Mr. R. A. Fairthorne agreed upon the necessity of properly stating the problem. To do this needs a realization of what is essential, and he had found lawyers and journalists, who habitually have to endeavour to see the essence of a problem they do not understand, better at this than mathematicians or engineers. Training in logic or philosophy greatly assists. Prof. H. S. Ruse commented upon the general keenness of engineering students. He suggested that what was perhaps more important to the engineering student than acquisition of technique was an appreciation of mathematical methods of thinking. Prof. S. J. Davies said that what he would wish for his students was that the mathematicians would teach them mathematics. He mentioned that a water turbine recently constructed according to the 200-year-old design of the mathematician Euler had an efficiency of more than 60 per cent.

Prof. Bickley thought that Sir Richard Southwell tended to exaggerate the difference between mathematicians and engineers; but that so far as it did exist, a friendly agreement to differ, along with a sincere attempt to understand one another's language, were desirable. He agreed with Mr. Fairthorne upon the importance of being able to discern the crux of any problem, and thought that the conciseness and precision of mathematical expression were a great help in this direction. He was glad that Prof. Ruse could agree about the keenness of engineering students. He could agree with Prof. Davies, and asserted that the one thing that the mathematics course should not appear to be was a sequence of *ad hoc* tricks for doing particular jobs. He did, however, think that the best chance of getting engineering students to appreciate mathematics for its own sake was to start with a recognition and an understanding of their interests and habits of thought.

CONTROL OF ENVIRONMENT IN HORTICULTURE

ON September 13, Section M (Agriculture) of the British Association held a discussion on "Control of Environment in Horticulture", over which Prof. H. D. Kay presided.

Dr. W. F. Bewley opened with a paper on "The Control of Heat and Light in Glasshouses". He pointed out that although plants in glasshouses are warmer and more sheltered than those in the open, the light intensity is reduced, moisture tends to accumulate, and crop rotation is scarcely possible. So the owner of glasshouses has problems to face which have no parallel in field cultivation.

The action of light must be considered in two different ways, namely, its photosynthetic effect on the production of carbohydrates with the consequent increase in growth, and its photoperiodic effect in deciding the actual time of flowering. Dealing with the former and referring to workers in the United States, Holland and Britain, he pointed out that by irradiating seedlings and young plants for three or four hours at the end of the day, it is possible to stimulate growth considerably, and in the case of cucumbers to achieve a worthwhile increase in crop. The main facts emerging from the experiments are that a high light intensity, 300–400 foot candles, is necessary, that the effect is mainly upon young plants and that the cost of the apparatus is high. The work has not yet reached a stage at which it could be recommended to commercial growers.

In photoperiodism, the case is much different, for by adjusting the length of day either by darkening or irradiating the plants, it is possible to retard or advance the flowering of many plants; and in the case of chrysanthemums to produce flowers for market at any time of the year. The apparatus is cheap, the duration of illumination short, and the process effective. He suggested that the assistance of physicists and engineers is necessary to solve the problem of light supply to increase growth and crop production, and that large-scale illumination from high-power lamps above the ranges of glasshouses might provide the solution. Until this is achieved, growers should site their nurseries in districts where winter light is at a maximum, glasshouse builders should design better lighted houses, and east-to-west houses should be built for propagating young plants and for growing pot plants during the winter.

Turning to the question of heat, Dr. Bewley said that considerable progress has already been made in thermostatic control. It is now possible to maintain a constant night temperature by applying thermostatic control to all systems of heating, including high- and low-pressure steam, steam-cum-water, oil-fired boilers, gravity feed and under-feed stokers using solid fuel. Despite these improvements, however, he said little has been done to cool the glasshouses during the summer, and he hoped the engineers would help.

On the subject of soil warming, he discussed the relative values of electrically heated wires and hot water circulated through small pipes. Soil-warming experiments have shown that raising the soil temperature provides bigger and cleaner roots, better plants, heavier crops and earlier maturity.

In conclusion, Dr. Bewley concluded that temperature control of glasshouses has already made good progress, but that control of light is still a problem for the future.

Mr. Raymond Bush, who followed with a paper on "Frost and the Fruitgrower", said that prior to 1935 no real attention had been given in Britain to May frosts. Indeed, the East Malling conference held that year showed very clearly that no one knew very much about them. From his extensive investigations, Mr. Bush gave many examples of frost injury which showed very clearly that cold air follows to some extent the behaviour of water in flowing over the land; it follows the contours, settling in valleys and hollows generally, or draining through them without causing damage. In view of the way in which great variations in crop production can be attributed to frost, he urged the necessity for selecting the correct site when planning new plantations, and expressed the view that areas of land suitable for future development should be earmarked for this purpose. So many orchards, however, are so badly sited that it is now a question of fighting the frosts and not preventing them. In this respect Mr. Bush discussed the value of shelter belts, but pointed out that they should contain gaps through which the cold air could drain away to levels below the orchards.

The talk was admirably illustrated with lantern slides. By this means, Mr. Bush gave a clear picture of the present attempts to fight frosts both in America and in Great Britain. He discussed the use of heater pots, the movement of air by mechanical means, including the helicopter, and the use of smoke generators and infra-red lamps. In conclusion, he was careful to point out that the wise choice of a site is still of fundamental importance.

The last paper, by Mr. F. A. Secrett, was on "Horticultural Crops in their Relationship to Water". Mr. Secrett said that the present world food shortage demands that the best use must be made of all available land, and that if the weight per acre could be increased, more land would be freed for other crops. He argued that as the growth of plants varies directly in accordance with the water supply, we experience gluts in wet weather and shortages in dry weather. Further, dry spells in the summer cause delay in sowing or planting the second crop. Armed with an efficient irrigation plant, growers are independent of rain. They can produce better crops of higher quality vegetables and continue their cropping programme unhindered by dry weather. Indeed, he claimed that some crops can be doubled in weight where watered overhead, especially if a little soluble nitrogen is added to the water.

Mr. Secrett discussed in detail the results of experiments on his farm carried out in co-operation with Rothamsted Experimental Station. For example, the application of 4 in. of water increased the yield of carrots by 20 per cent. Sugar beet producing 20 tons of roots in the control plot gave 29 tons in plots receiving 10 in. of water by overhead irrigation, and in addition to this the sugar content was increased considerably. Speaking on the question of quality, Mr. Secrett claimed that when vegetables are irrigated correctly they improve in flavour, and gave examples of this in the case of radish, lettuce and cauliflower. Overhead irrigation is a very valuable process in the hands of the grower.

The advantages of overhead irrigation are many. The grower is independent of rain, and can continue to carry out his crop programme and cultivations in the driest weather. Quality is improved, weight of crop per acre is increased, a high plant population

is possible, and pests due to drought are controlled. Soluble fertilizers can be added to the water and minor elements also supplied in this way. Production is speeded up and a greater variety of vegetables can be grown.

The discussion was opened by Lord Bledisloe, who was followed by Sir John Russell and others. In replying to questions Dr. Bewley said that, whereas glasshouse growers as a whole are not attracted by cloches, new entrants into horticulture are learning how to use them and many seem satisfied with the results. He thought that no objection could be raised to steel houses on the basis of more severe temperature fluctuations. He had examined most glass-substitute materials, and while some are satisfactory for a year or two, those that are cheap enough for commercial purposes do not stand up to weather conditions very long. He had long been interested in waste heat from power stations and factories. Usually the waste hot water is not hot enough for circulating in the glasshouse pipes, and there is the disadvantage of injurious fumes and grit owing to the close proximity of the industrial plant.

Mr. Bush, in reply to questions, emphasized that shelter belts should always contain gaps through which the cold air can drain away. The lime makes a good shelter belt, but must not be too dense.

Mr. Secrett said that the addition of nitrate of potash in the irrigation water had always given better results than nitrate of soda, but he could not say why. It was perhaps surprising that the very small amounts of fertilizers used in the water had such big effects, but it was probably due to the repeated applications. There is no limit to the area that can be irrigated provided the spray lines are available. His units are four acres, and at Milford he irrigated twenty acres from one centre.

INTER-UNIVERSITY RELATIONS AND EXCHANGES

THE question of inter-university relations, which was discussed on July 21 at the Congress of Universities of the Commonwealth, is partly an administrative and partly an academic question. On one hand, it is necessary to make such business arrangements between the universities as will enable a young student or teacher to move from one university to another without academic loss of standing or financial embarrassment. On the other, it is necessary to make such an exchange sufficiently attractive from an academic point of view for the man or woman contemplating a temporary migration to make sure that it will be academically advantageous. No young man with academic ambitions —which will probably be centred in his own country— will welcome the idea of an exchange which will leave him for a year in a university which is not equipped whether in its libraries or laboratories to enable him to develop his own research. Conversely, no university will welcome a teacher who regards himself as nobly and self-sacrificingly spreading the joys of learning to universities less lucky than his own.

This latter problem can only be met by the universities knowing each other better. Though many of the speakers at the Congress admitted that their universities were ill-equipped for certain types of work, almost all were able to claim that in one subject or another they were doing work, or had work waiting to be done, which would be most attractive to a young teacher anxious to become master of some topic. The vast quantity of work awaiting the historian of Australia is an example. The first essential is that the universities should know each other far more intimately than they do at present. The Congress agreed to recommend that the universities of each country should be encouraged to form an agency which should act as an instrument of communication with universities elsewhere. Further, since the whole Congress meets only every five years, it was suggested that, in the years between such meetings, vice-chancellors and senior members of staff should visit each other as frequently and as regularly as possible.

The Congress passed several resolutions designed to make the traffic between universities easier and less hazardous. The first resolution dealt with the announcement and advertising of vacancies. It is in this stage that the central office of the Universities Bureau can be of great assistance. It can keep in touch with the appointments committees of the several universities and provide information about the type of post to be filled. It can arrange for candidates to be interviewed by a panel composed both of experts in any subject and of men acquainted with the university which is advertising a vacancy. It can arrange for the successful candidate to be given expert advice about what he may expect to find at the university to which he is going. But it cannot fulfil these functions unless it is very fully informed of the needs of the advertising universities. Many posts are filled by a local man although the formality of advertising may be maintained. It is obviously undesirable in these cases to put candidates to the expense and inconvenience of applying for a vacancy which is more nominal than actual. But if the Bureau receives the help it needs, it can be of immense use to any universities arranging exchanges.

The second resolution dealt with the question of superannuation benefits. Though the importance of ensuring that a man does not suffer financial loss if he goes temporarily to another university needs no stressing, the method of achieving this end is extremely complicated. A committee was set up to inquire into the possibilities.

The question of travelling expenses is closely related. The cost of moving from one part of the Commonwealth to another is in itself sufficient to make the idea impossible for most aspirants. It was agreed to approach bodies or foundations which may have resources available for this purpose; and the Congress was given to understand that proposals would be sympathetically received by some at least of these foundations. It is quite certain that no exchanges can be successfully arranged unless the finances are arranged in such a way as to make the project if not attractive at least reasonable, from the point of view of the scholar or student who is contemplating migration.

The Congress had before it a report written by Mr. Douglas Veale, registrar of the University of Oxford. Mr. Veale has recently been in Australia and wrote an account of his visit and put forward several recommendations as a result of what he had learned. As his memorandum took the form of a report to his own University, it was not discussed by the Congress; but it included the greater part of what the delegates to the Congress were seeking,

and, moreover, it put it in a form which implied that it would not be impossible to implement the proposals almost at once.

Mr. Veale's first recommendation was based on the fact that universities in Britain are overcrowded and under-staffed. A great part of the extra burden which is now being borne in British universities could be shared with young postgraduates from abroad—preferably young men immediately after their appointment to lectureships at their own universities. There would be no difficulty in asking them to take a few hours teaching, by which means they could supplement their incomes without making it impossible to do research work on their own. Mr. Veale found that the idea of combining teaching and research in this way would be welcomed by the Australian universities; and there is every reason to think that it would be to the advantage both of the teacher and of the taught.

Mr. Veale's other recommendations were closely in line with the resolutions which the Congress had passed. The discussion and the resolutions showed two things very clearly: first, a realization on the part of universities in all parts of the Commonwealth that it would be greatly to the advantage of all concerned if they could know each other better, and make more frequent exchanges of men and ideas; secondly, a determination to overcome the difficulties which are at present obstructing the way. A great deal depends on the reports which will be issued by the committees set up by the Congress at Oxford.

HEALTH OF THE PEOPLE OF BRITAIN

THE report of the Ministry of Health for the year ended March 31, 1947 (Cmd. 7441, pp. 1–204. London: H.M. Stationery Office, 1948. 3*s.* 6*d.* net), records, in general, another favourable bill of health. In spite of the continuance of rationing and other controls, and of the various additional ingredients of that too-familiar conception 'austerity', the vital statistics and other features of this report suggest that austerity is not really doing the population of Britain very much harm. In the period covered by the report the birth-rate rose to 19·1 per thousand of the population, a figure which is the highest recorded since 1923; and the infant mortality-rate fell to 43, which is a new low record. Maternal mortality also fell to a record low level of 1·43 per thousand total births, and death-rates at ages of less than fifteen years from measles, scarlet fever, rheumatic fever and heart disease were all the lowest ever reported. The death-rate was 12·0, which is the lowest since the previous best (11·6) in 1938.

One of the outstanding features of the year was the success of the diphtheria immunization policy. Deaths from this disease numbered 472, instead of the 2,361 reported in 1938, and there was a fall of 36 per cent in the notifications of diphtheria as compared with the year 1945. The greatest proportional decline was in the age-group 5–10 years (42 per cent), and the next greatest in the age-group 10–15 years (39 per cent). These figures speak for themselves; but the warning is issued by Sir Wilson Jameson that continual control of the antigens used for the immunization and maintenance of a high proportion of immune children are essential if this excellent result is to be maintained.

Encouraging also is the fact that in 1946 new low records were reported for deaths in Britain from respiratory and other forms of tuberculosis. In 1946 the number of deaths from this cause was 22,847, whereas ninety years ago it was 66,000 in England and Wales among a population half its present size. The report wisely avoids complacency about this advance in the control of a disease which still causes nearly one third of all deaths at ages between fifteen and thirty-nine. More beds for tuberculous cases are urgently required to accommodate the long waiting lists, and just as urgent is the need for more staff. If, says the report, the staff had been available, half the patients awaiting treatment could have been given beds during the last two years.

Notifications of whooping cough were higher than in 1945, a fact which will not surprise the parents of young children; but deaths from this distressing disease were lower. A reliable prophylactic vaccine has yet to be found, but experimental work on this problem is being energetically continued.

A serious feature of the report is the great increase of syphilis. New male cases at treatment centres rose to 10,705, a figure which is nearly double that of the previous year. Female cases, on the other hand, were 6,970 compared with 5,527 in 1945. An increase of 1,654 in the deaths from cancer is also recorded; but the report emphasizes that modern methods of treatment of this disease can do much to relieve the pain and suffering that it causes.

Among the many interesting facts recorded in the report is the slight decline since the middle of 1945 of about three-quarters of a pound in the average weights of adults aged twenty-five to fifty-four; but the improvements in the heights and weights of school children recorded during the later years of the War have been, on the whole, maintained. Nutritional surveys have shown that only 33 out of 7,216 persons in various parts of Britain could be classified as badly nourished.

During the first six months of 1946, smallpox was a continual menace because of the heavy return traffic from India by sea and air; but the energetic action of the health authorities confined the outbreaks that occurred within narrow limits. Readers of this part of the report will realize how much steady and unrecorded work is continually being done to safeguard the health of the people; and travellers by sea and air who read it in conjunction with the section dealing with the control of airborne and seaborne disease will understand that any regulations to which they have to submit when they enter Britain are not lightly imposed. In these days of rapid travel over great distances, it is clearly the duty of every traveller to see that he does not wittingly carry into the country which he visits diseases which may be deadly to the people living there.

It is not possible in a short review to record all the other interesting features of this comprehensive report. Apart from the facts it gives about the incidence of diseases other than those mentioned above, it includes discussions of the work of the emergency public health laboratory service, now a permanent feature of the medical organisation of the country, and of the excellent work being done on all aspects of maternal care, nutrition, the improvement of hospitals and their conflict with the building restrictions, water supplies, health publicity and other aspects

of that proteus which we call public health. If there be anyone who doubts that the best effort and brains are being employed in this beneficent work, he should read this report and learn the truth. It will tell him, not about politics, but solely about the control and relief of suffering and the maintenance of the health of everybody. For that reason all those whose work is recorded or implied in its pages must feel gratified that their efforts have produced, in spite of the difficulties of these times, so much that is positive good and so much, also, that points to even greater achievements in the future. G. LAPAGE

BRITISH COUNCIL

ANNUAL REPORT

THE report of the British Council for the year ended March 31, 1948, refers to the withdrawal of its activities from Iceland, Switzerland, French North Africa, Bolivia, Ecuador and Paraguay and the closing of institutes and provincial offices in Belgium, the Netherlands, the Argentine, Colombia, Chile and Peru. To meet the reduction in funds for 1948–49 from £3,500,000 in 1947–48 to £3,150,000, further reductions in services such as books, drama and films are also being made. During the year, however, the educational work of the Council has steadily developed. It has continued to secure or to recommend British candidates for posts in foreign universities, and forty-two posts, mostly professorships and lectureships, are now subsidized and filled by the Council, and of these ten were filled in 1947–48. The Council has also assisted in the recruitment of suitably qualified staff from Britain for British and foreign schools in many countries overseas, and during the year launched a new scheme of bursary awards designed to bring to the United Kingdom persons who would not normally qualify to obtain scholarships but who, being actively engaged in industry or professional work, would benefit from a short stay in Great Britain and from mixing with those of like occupations.

The large volume of scientific bibliographical inquiries and requests for scientific information has made it necessary to amalgamate the science libraries and scientific information services. Assistance was given to the convening bodies of scientific conferences held in the United Kingdom, and a conspectus of current scientific research in Britain has been compiled and is maintained with the co-operation of numerous bodies and by visits of Council staff to university research departments. The publication *Monthly Science News* has been replaced by the larger journal *British Science News*, and assistance has been given in placing agricultural scholars of the Council and in arranging tours for some fifty agricultural visitors. The collection of seed samples from a large number of countries was organised at the request of various research stations, and advice and assistance given to 103 private students from ten countries and to 32 engineers and technicians from thirteen countries on visits to Great Britain. The medical library and information service has expanded considerably, most of the 284 books added being received for review in the *British Medical Bulletin*, while 310 copies of the monthly list of new British medical publications are circulated to libraries and institutions abroad.

Programmes of work were arranged for more than forty overseas medical graduates holding British Council scholarships, and the Council is also arranging programmes or accommodation for most of the 'fellows' appointed by the World Health Organisation who elected or were advised to study in Britain. The Council's organisation for receiving visitors was increasingly used by Government departments, overseas Governments, universities and professional societies. Besides the 599 who came as the Council's guests, forty per cent of whom were concerned with science, medicine, agriculture and engineering, 306 who came without financial assistance from the Council had programmes arranged for them. The Council also financed a limited number of delegates to scientific conferences and cultural events, and was also invited by several universities to assist recruitment for their summer schools. The Council took the initiative in convening a committee representing British universities to discuss the possibility of organising a series of summer schools in 1948, designed particularly for American students. The scheme involves a total of 700 students, for nearly 200 of whom from overseas the Council has accepted responsibility.

Reports on activities overseas are considerably curtailed in comparison with previous reports and contain little reference to scientific activities except in Finland, Italy, Poland and Brazil. The slightness of the accounts of the scientific activities of the Council constitutes one of the chief criticisms of the report, although the figures quoted for exchange of students and the like do not suggest that science is not well represented in the Council's activities, or support the impression that might be derived from other passages of the report that the Council is becoming increasingly an instrument of political warfare.

It is perhaps natural that, in view of the searching examination to which the activities of the Council were subjected by the Select Committee on Estimates in a report published last April, some space should be given to comment on the Select Committee's report. While satisfied that the evidence indicated that the Council is regarded as outside politics and that its work is not associated with propaganda or the political feeling of the day, the Select Committee directed attention to the need for introducing an improved permanent service, and questioned the necessity for so heavy a staff at headquarters. Without going closely into the important question of recruitment, the report indicates that the British Council itself leans towards the view of the Select Committee that Civil Service standards should be applicable in recruiting the bulk of its staff. No agreement has yet been reached, however, on the question of the grades and conditions of service which will ensure the maintenance of efficiency everywhere and adequate representation overseas, nor does the fundamental question appear to have been considered whether the service of the Council should constitute a closed service or whether its staff should comprise mainly those seconded for fairly short periods and then returning to academic life or their normal occupation. The Council hopes for some reduction in staff as a result of careful overhaul of establishments at headquarters, but fears that the financial savings will be absorbed by overdue improvements in staff conditions. Staff questions may not figure so prominently in future reports, but whether they do or not, the report might reasonably be expected to provide fuller public explanation as to how and by whom the plans for our cultural strategy are prepared.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, October 9

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Mr. Haswell Alder: Inaugural Address as President.

Tuesday, October 12

SCIENTIFIC FILM ASSOCIATION (at the Royal Institution, Albemarle Street, London, W.1), at 10 a.m.—Conference on "The Film in Scientific Research" (to be opened by Sir Robert Watson-Watt, F.R.S.).

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. Bernard Fagg: "The Beginnings of Art in Northern Nigeria".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. S. Whitehead: Inaugural Address as Chairman.

ILLUMINATING ENGINEERING SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. J. M. Waldram: Presidential Address.

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. J. M. Wordie: "Explorations in Graham Land and in the South Shetlands".

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the Midland Hotel, Bradford), at 7 p.m.—Mr. J. Foster Beaver: "The Romance of Wool".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (joint meeting with the NORTH-WESTERN BRANCH of the INSTITUTION OF ELECTRONICS, in the College of Technology, Manchester), at 7.30 p.m.—Mr. D. Edmundsen: "Electronic Development in Instrumentation".

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 8 p.m.—Dr. Ruth Griffiths: "Measuring the Abilities of Children in the First Two Years of Life".

Wednesday, October 13

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "The Control of Milk Quality" (to be opened by Mr. E. B. Anderson and Mr. L. J. Meanwell). (Members of the Food Group of the Society of Chemical Industry are invited.)

PHYSICAL SOCIETY (joint meeting of the COLOUR AND OPTICAL GROUPS, at Northampton Polytechnic, St. John Street, London, E.C.1), at 3 p.m.—Scientific Papers.

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Pentti Eskola: "The Problem of Mantled Gneiss Domes" (Fourth William Smith Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. Smith: Inaugural Address as Chairman.

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting of the MICROBIOLOGICAL AND NUTRITION PANELS, at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6.15 p.m.—Dr. E. F. Gale: "The Role of Vitamins (and Metals) as Co-enzymes in Bacterial Metabolism".

ROYAL INSTITUTE OF CHEMISTRY (at I.C.I. (Paints), Ltd., Wexham Road, Slough), at 6.30 p.m.—Mr. G. R. Cornish: "Methods of Determining Molecular-Weights of Polymers"; Mr. C. H. Young: "The Performance of Paint Films".

Tuesday, October 12—Wednesday, October 13

SOCIETY OF CHEMICAL INDUSTRY (at Geneagles Hotel, Gleneagles).—Convention on "High Vacua".

Thursday, October 14

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Joseph Pearson: "The Marsupial Placenta".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Small Physics Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. W. West: "The Accuracy of Measurements by Rayleigh Disc".

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (joint meeting with the NORTHERN LOCAL COMMITTEE of the BRITISH OPTICAL ASSOCIATION, in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Mr. W. J. Wellwood Ferguson: "Colour".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. K. B. Ross and Mr. D. N. McKinlay: "Integration of Operations in a Large Refinery".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. O. Ackerley: Inaugural Address as Chairman.

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Friday, October 15

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. W. A. W. Fox: "Transverse Navigation, an Alternative to the Grid System".

ROYAL INSTITUTE OF CHEMISTRY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Prof. H. B. Nisbet: "Anæsthetics".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. Mungo Campbell: Presidential Address.

SOCIETY OF DYERS AND COLOURISTS, MANCHESTER SECTION (at the Gas Department Showrooms, Manchester), at 6.30 p.m.—Prof. W. T. Astbury, F.R.S.: "Adventures with the Electron Microscope".

PLASTICS INSTITUTE (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—"A Review of Thermoplastic Materials" (Chairman's Address).

SOCIETY OF GLASS TECHNOLOGY, NORTH-WEST SECTION (at the Gas Showrooms, Radiant House, St. Helens), at 7.15 p.m.—Dr. B. P. Dudding: "Statistical Methods and Industrial Efficiency".

Saturday, October 16

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Mrs. Bertild Bekker: "Peoples in the Mountains of Central Celebes".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURESHIP IN MECHANICAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (October 16).

SENIOR ASSISTANT IN STRUCTURAL ENGINEERING, a RESPONSIBLE LECTURER IN ORGANIC CHEMISTRY, LECTURERS (2) IN CHEMISTRY, and a LECTURER IN MECHANICAL ENGINEERING, in the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough (October 16).

LECTURER IN BIOLOGICAL SUBJECTS (Botany and Zoology)—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (October 16).

RESEARCH ASSISTANT for experimental work in collaboration with clinical research teams, in particular in the Department of Otology—The Secretary, Middlesex Hospital Medical School, London, W.1 (October 16).

LECTURER IN MECHANICAL ENGINEERING DRAWING to H. N. C. standard—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs. (October 16).

LECTURER IN THE DEPARTMENT OF PHYSICS AND MATHEMATICS of the City Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (October 18).

SENIOR ASSISTANT IN ORGANIC CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (October 20).

PLANT PATHOLOGIST to undertake research on virus diseases of fruit plants, a PHYSICAL CHEMIST in the Plant Protective Chemistry Section to work on problems involved in the control of pests and diseases of fruit, a RESEARCH ENTOMOLOGIST to be attached to the Plant Protective Chemistry Section for laboratory and field studies of insecticides and their mode of action, a JUNIOR ORGANIC CHEMIST in the Biochemistry Section for work on the organic constituents of fruit-bearing plants, an HONOURS GRADUATE in natural science with special interests in plant physiology and botany for work on frost damage to fruit plants, and an ASSISTANT for maintenance and construction of experimental apparatus, including thermo-electric instruments, for work on frost damage to fruit plants—The Secretary, East Malling Research Station, Maidstone, Kent (October 23).

LECTURER IN PHILOSOPHY—The Very Reverend the Dean, Christ Church, Oxford (October 25).

SMITHSON RESEARCH FELLOWSHIP—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (October 30).

LECTURER IN PHYSICAL CHEMISTRY in University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (October 31).

ASSISTANTSHIP IN THE DEPARTMENT OF ZOOLOGY—The Secretary, The University, Old College, Edinburgh 8 (November 1).

CHIEF MECHANICAL ENGINEER (under the Chief Mechanical and Electrical Engineer) in the Production Department at Headquarters in London—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/90 (November 15).

PROFESSOR OF BOTANY at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (December 15).

READER or SENIOR LECTURER IN BIOCHEMISTRY in the Department of Physiology, University College of the West Indies—The Secretary, Special Committee of the Senate on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (January 15).

TUCKER-PRICE SCIENTIFIC RESEARCH FELLOWSHIP for research in Mathematics, Science, or an allied subject—The Secretary, Girton College, Cambridge (January 15).

LECTURER with special qualifications in ANALYTICAL CHEMISTRY and some inorganic interests, and a LECTURER with special qualifications in ORGANIC CHEMISTRY—The Secretary, The University, Aberdeen.

LABORATORY TECHNICIAN IN THE DEPARTMENT OF PATHOLOGY—The Pathologist, Royal Devon and Exeter Hospital, Exeter.

LABORATORY TECHNICIANS IN THE BIOCHEMICAL RESEARCH DEPARTMENT—The Secretary, Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5.

GRADUATE (or equivalent) FOR ANALYTICAL LABORATORY—The Assistant Secretary, British Coal Utilization Research Association, Randall Road, Leatherhead.

SENIOR ASSISTANT IN CIVIL ENGINEERING, and a LECTURER IN MECHANICAL ENGINEERING—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

ECONOMIC STATISTICIAN or ECONOMIST for investigations in economic and social relations between agriculture and industry, and a RESEARCH ASSISTANT IN RURAL SOCIAL ORGANISATION—The Secretary, University of Oxford Agricultural Economics Research Institute, Parks Road, Oxford.